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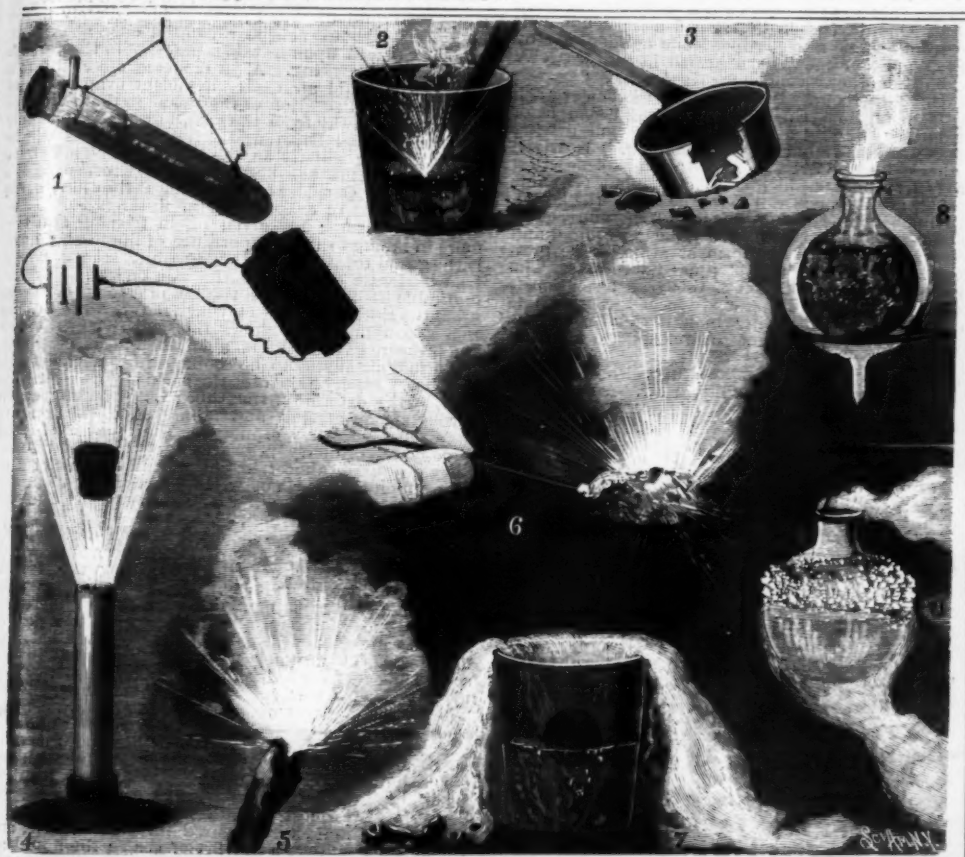
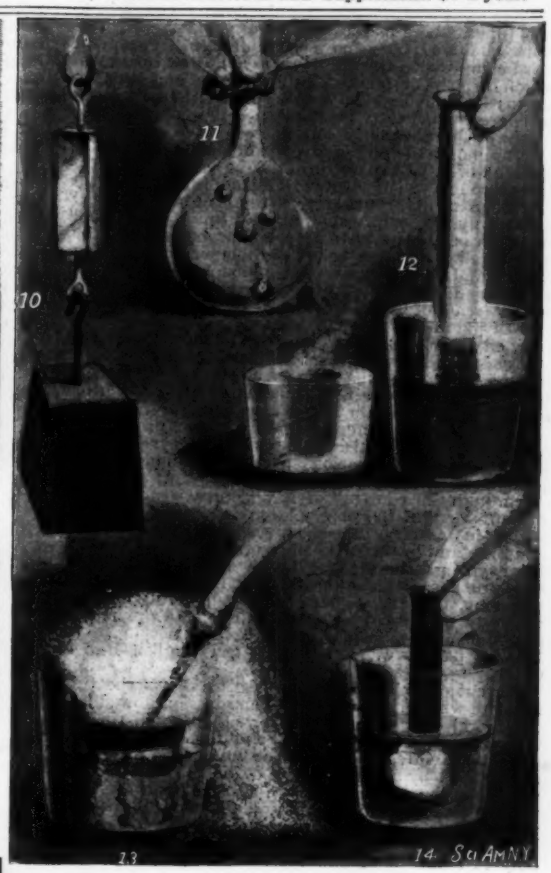
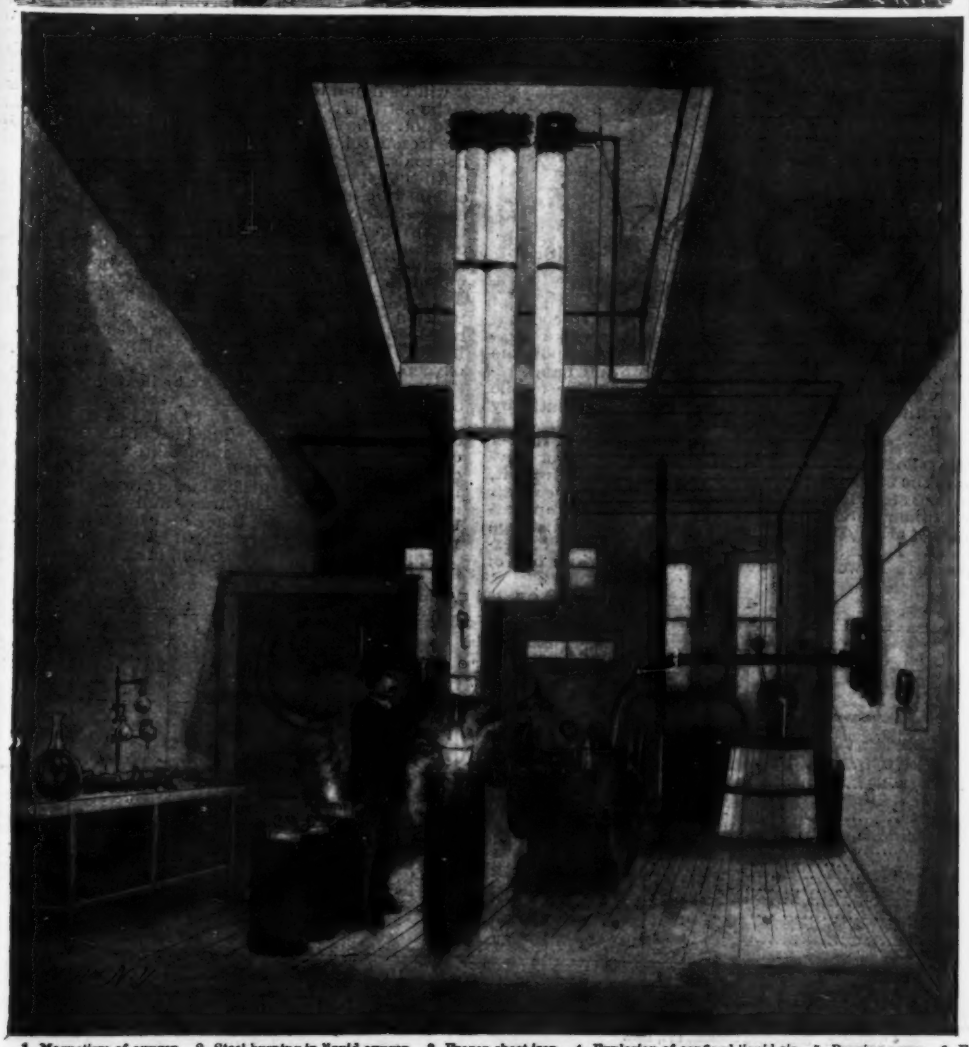
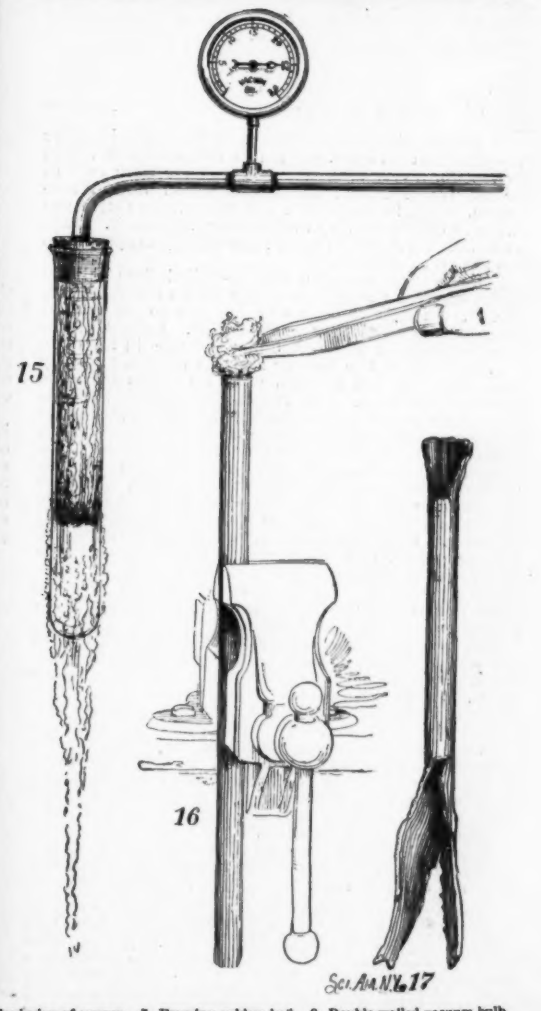





1. Magnetism of oxygen. 2. Steel burning in liquid oxygen. 3. Frozen sheet iron. 4. Explosion of confined liquid air. 5. Burning paper. 6. Explosion of sponge. 7. Freezing rubber ball. 8. Double walled vacuum bulb. 9. Boiling liquid air. 10. Frozen mercury. 11. Liquid oxygen in water. 12. Frozen whisky. 13. Carbonic acid snow. 14. Burning carbon in liquid oxygen. 15. Liquid air boiling in a vacuum. 16 and 17. Force of liquid oxygen.

PLANT FOR LIQUEFYING AIR—EXPERIMENTS SHOWING PROPERTIES OF LIQUID AIR.

## LIQUID AIR AND ITS PHENOMENA.*

By Prof. W. C. PECKHAM, Adelphi College.

RENEWED interest has recently been awakened in the liquefaction of air by the announcement that it can be produced in practically unlimited quantities. This result has been brought about by the development of the method of expansion, and its use in a new and ingeniously devised apparatus. Credit for this is due to Mr. C. E. Tripler, of New York, who has for many years been engaged in the study of this problem.

Our first page illustration shows the appearance and arrangement of his plant. It consists of a triple air compresser, a cooler, and a liquefier. The compresser is of the ordinary form, having three pumps upon one piston shaft working in a line. The first gives 60 pounds pressure; the second raises this to 750 pounds, while the third brings the air under a compression of 2,000 pounds per square inch.

After each compression the air flows through jacketed pipes, where it is cooled by city water. For this work about 40 horse power is employed. After the third compression the air flows through an apparatus which disposes of some of its impurities and it passes on to the liquefier. It is this part of the apparatus which constitutes Mr. Tripler's special invention. By means of the peculiarly constructed valve, whose details are not made public, a portion of the compressed air is allowed to expand into a tube surrounding the tube through which the remaining air is flowing. This expanded air absorbs a large amount of heat from the air still under compression in the inner tube. The contents of the inner tube are thus cooled. In this way the air is brought below the temperature of liquefaction and its pressure is very much reduced, so that, upon opening the valve at the bottom of the apparatus, a stream of liquid air is received, flowing out with scarcely more force than the water from our ordinary city service pipes. Thus the liquefaction of the air is accomplished by the "self-intensification of cold" produced by the expansion of a portion of the compressed and cooled air, without employing any other substance to bring about this result.

In this lies the difference between the process employed by Wroblewski and Olszewski many years ago, in the liquefaction of various gases, and finally, in the liquefaction of air by Olszewski and Dewar.

Through the courtesy of Mr. Tripler, we are able to present a cut of the original apparatus by means of which, in January, 1890, the first liquid air was made in America, and probably in the world, by this means. It is known that the method by expansion of air under pressure has been employed both in England and Germany, but the earliest published date connected with any of these experiments is 1895, and previous to that time, as Mr. Tripler states, his application for an English patent was on file in the English Patent Office.

Our cut of this original apparatus shows the tube through which the air under compression flowed into the spiral coil. Having traversed this coil, it rose through a tube (not seen) in the middle of the coil and passed the valve shown at the top. The whole was surrounded by a glass tube open at the bottom. By the expansion of the escaping air the coil and the inner tube were so cooled that liquid air trickled down the pipes and dropped out at the bottom of the tube.

This most interesting piece of historical apparatus is only 12 inches long and $1\frac{7}{8}$ inches in diameter. Its capacity was of course extremely small as compared with the great plant which will deliver from 30 to 40 gallons of liquid air per day of 10 hours, with an expenditure of from 40 to 50 horse power, and its operation must have been extremely slow, as compared with the operation of the modern plant, which will give liquid air in less than 15 minutes after the pump is started.

As fast as the liquid air is drawn from the liquefier it is placed in tin cans, packed in felt, in which it can be kept for a very long time. Cans have been sent as far as Lynn, Mass., in one direction and Washington, D. C., in the other, and the contents were not seriously diminished by evaporation in transit. Such a can holding 3 gallons would not wholly evaporate in less than 8 to 10 hours.

Prof. Dewar invented a double-walled glass bulb, in which between the walls a high vacuum is formed (see Fig. 8). In this the air will last five to six times as long as in an ordinary packed dish. Indeed, it lies practically quiet without boiling, while in an open dish (see FIG. 9) the boiling is quite violent, and very soon the walls are covered with ice frozen from the moisture of the air. This is doubtless the coldest free liquid that has ever been produced. Its boiling point at the ordinary pressure of the atmosphere is —191° C.

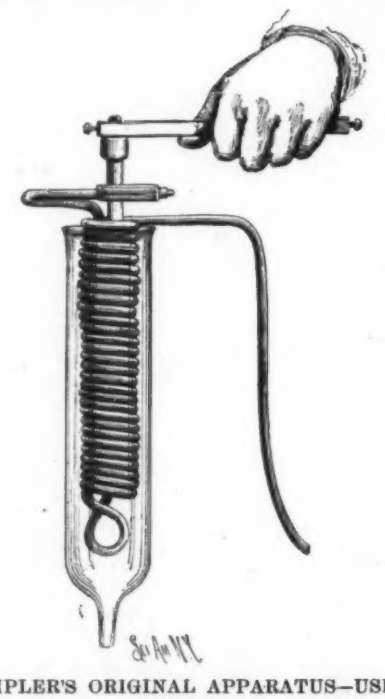
An extended table of the physical constants of the "so-called" permanent gases is embodied in this article and will doubtless interest our readers. A glance at this will show that the boiling point of the air is the lowest temperature thus far attained at atmospheric pressure. Only hydrogen and helium have lower boiling points, and neither of these has been liquefied up to this time in a free state, that is, at atmospheric pressure. The same statement can be made with regard to air boiling in a vacuum. This has the lowest temperature yet attained.

The possession of a large quantity of a liquid at so low a temperature makes it possible to perform many experiments of a very startling and marvelous character. When a dishful of the liquid air is dipped from the can, it boils so violently that drops of it are projected to quite a distance. This continues until the dish is cooled to the temperature of the liquid, when it becomes quiet, simmering gently. In this condition it is turbid, containing solid particles of carbonic acid and possibly ice. These may be filtered out through filter paper, and the liquid is seen to be of a delicate shade of blue, clear as water.

Since the boiling point of nitrogen is 13° C. below that of oxygen, it follows that, in the first boiling, nitrogen is distilled from the oxygen as alcohol may be distilled from a mixture of alcohol and water through the difference between their boiling points. By this means the liquid air becomes very much richer in oxygen. The liquid air would at first contain only 20 per cent. of oxygen, but after boiling for a while the proportion of oxygen increases to 75 per cent. If the liquid be poured upon a block of ice, it bounds off like water from a hot stove. The ice at the freezing point is 344° F. hotter than the liquid air—a distance of 132° greater than separates boiling water from ice. We cannot comprehend it any better than we can comprehend the space which separates us from the sun. Although so cold, the hand may be dipped into the liquid or the liquid may be poured into the hand without producing much sensation, since the heat of the hand evaporates the liquid so quickly that a layer of vapor is formed around the hand; in other words, the liquid is thrown into a spheroidal state with reference to the hand. If, however, contact does take place between the skin and the liquid air, a most serious burn results. One day, when Pictet had a burn upon his hand from fire, he also produced one accidentally by liquid air; the ordinary burn healed in ten or twelve days, but the other was open for six months.

Fig. 4 shows a copper tube 2 inches in diameter, with walls ¼ of an inch thick. On pouring a couple of fluid ounces of liquid air into the tube, and driving a wooden plug firmly in with a hammer, it is driven out almost immediately, and with such violence that boards overhead are indented by it. About 100 cubic feet of air are compressed into one gallon of the liquid, occupying 231 cubic inches. The liquid, therefore, occupies but $\frac{1}{748}$ of the space filled by the gas at first, and on returning to its gaseous form at atmospheric pressure, it must expand to 748 times its volume. The enormous pressure produced in this transformation is thus apparent. It would scarcely seem to be possible to construct apparatus in which it could safely be stored and allowed to come to atmospheric temperatures.

Fig. 3 shows the effect produced upon iron by reducing its temperature to that of liquid air. An ordinary



TRIPLER'S ORIGINAL APPARATUS—USED IN 1890.

tin dipper placed in the liquid and allowed to cool till boiling ceases becomes brittle and breaks like glass upon being struck against a table or thrown upon the floor. Copper and platinum, on the other hand, remain tough at the lowest temperatures. The tensile strength of iron would be increased very greatly by cooling.

Fig. 7 shows a dish of liquid air in which a rubber ball is floating. It will be noticed that the vapor flows over the edge of the dish, not rising in a cloud from it, as does steam, since it is much heavier than gaseous air at ordinary pressures. This vapor presents the appearance of a cloud of steam and would be easily mistaken for it. The chill which the hand receives on being exposed to it would, however, quickly convince one of the difference. When the rubber ball has been cooled to the temperature of the liquid, it becomes exceedingly brittle, and on being thrown against a wall flies into many pieces. A very curious effect produced upon a billiard ball or other article of ivory by cooling it to the temperature of liquid air has not been explained. On exposing it to the arc light for a few seconds and viewing it immediately in a darkened room, it shines with a brilliant green phosphorescence. It is possible that many other substances, such as eggs and bone, may be found to possess the same property. Whisky and alcohol are frozen with little difficulty by means of this liquid. It is a curious experiment (see Fig. 12) to hold a tube in which is liquid air in a glass of whisky, which in a few minutes becomes frozen solid. On warming the outside of the glass the solid whisky may be removed, and we have a whiskey tumbler composed of whisky itself, but the whisky is in a condition suitable only for consumption in the Klondike.

A jet of carbonic acid directed into a dish floating in a glass of liquid air (see Fig. 13) is immediately frozen and forms carbonic acid snow, in the open air, which, on being placed upon a table, passes into the gaseous state without melting. A jet of steam directed into a glass of the liquid air causes a violent evaporation of the air and condensation of the steam, so that a cloud of particles rolls away from the dish, but in a remarkably short time round hailstones of the size of peas will be found floating quietly in the liquid air. They have cooled from + 212° to —312° Fah. in the short space of a few seconds. Consider how much heat they have given up. The heat of evaporation of water is 967° Fah.; 212° more to zero; 144° given off in freezing and 312° more in falling to the temperature of liquid air; 1,636 is the grand total. Eighty degrees per second would be a moderate estimate of the rate of loss. More remarkable still is it to see the air of a room condense upon the sides of a tube in which liquid air is boiling in a vacuum. Fig. 15 shows this experiment. When the pressure gage registers about half an atmosphere, the liquid air is seen to be boiling in the tube with violence. Ice crystals from the moisture of the outside air coat the exterior of the tube; but trickling down through these crystals and falling off to the floor are the drops of the atmosphere of the room condensed directly at ordinary pressure into the liquid form. They disappear almost instantaneously in a cloud of vapor upon the floor, not wetting it at all—a most singular sight to see a liquid which does not wet the surface upon which it strikes.

A most striking experiment has been designed by Mr. Tripler, as were many of the experiments which have been already described, to show the tensile strength of frozen mercury. Fig. 10 illustrates this. Into a paper dish is poured a quantity of mercury. Into the ends of the dish have been inserted a pair of heavy screw eyes. If this dish is placed in a basin of liquid air, the mercury is quickly converted into a solid, since its freezing point is relatively high; 30 below zero. Now this, suspended in the manner shown, will support a heavy weight for a long time. A block an inch square in cross section will not melt under 20 to 30 minutes. Of course, anything else could be done with the frozen mercury which might be done with any other similar piece of metal; as, for example, it might be used to drive a nail.

Possibly the most striking experiment is this: A quantity of liquid air is poured into a teakettle, and the kettle is set over a hot fire of coals; the liquid air evaporates and shoots in streams from the spout of the kettle in a straight column to the height of 3 to 4 feet—a sight which Watt never dreamed of. While this is going on, if a glass of water is poured into the kettle, it will be found to be frozen in a very short time; and if the kettle is removed from the fire, its under surface is found to be covered with the carbon dioxide of the fire frozen solid within a couple of inches of the red hot coals.

All the experiments usually performed in illustrating combustion in oxygen may be performed with heightened effect by means of liquid oxygen, separated from the nitrogen in the manner already described. A piece of sponge, saturated with the liquid oxygen, when touched by a taper from a safe distance, explodes with violence and is blown into fine shreds (see Fig. 6).

A most beautiful experiment is shown in Fig. 5, in which a newspaper crumpled into a roll has been saturated with liquid air, and is set on fire at one end. It burns with violence, but not so rapidly as in the liquid oxygen.

An electric light carbon may be heated to a red heat at its tip, and then plunged vertically into a deep glass of liquid oxygen, as in Fig. 14. A most singular combustion takes place. The heat of the carbon evaporates the oxygen in its immediate vicinity, and the carbon burns with great brilliancy and violence, forming carbon dioxide, which is largely frozen in the liquid air before it reaches the surface and falls back to the bottom of the dish, so that the combustion is maintained and its products retained within the dish.

Of course matches will be relighted, a piece of paper

PHYSICAL CONSTANTS OF (SO-CALLED) PERMANENT GASES.

| | Critical Temperature. Centigrade. | Critical Pressure. Atmospheres. | Boiling Point at Ordinary Pressure. Centigrade. | Freezing Point. Centigrade. | Freezing Pressure. Mm. | Density of Gas. | Density of Liquid at Boiling Point. | Color of Liquid. |
|---|---|---|---|---|---|---|---|---|
| Carbon dioxide, $CO_2$ | 31° [1] | 77·0 | —78·2° [2] | —79° [2] | 760 [2] | 22 | 0·83 @ 0° [4] | Colorless. |
| | | 44·0 | | | | | | |
| Ethylene, $C_2H_4$ | 9·5·0 | 58·0 | —110 [3] | | | 14 | | |
| Hydrogen, $H_2$ | —234·5 [4] (Theor.) | 20·0 | —243·5 [4] (Theor.) | | | 1 | | Colorless. |
| Nitrogen, $N_2$ | —146 | 35·0 | —194·4 | 203 —214 Mean 208 | 60 | 14 | 0·885 | Colorless. |
| Carbonic oxide, CO | —139·5 | 35·5 | —190·0 | —207·0 | 100 | 14 | | Colorless. |
| Argon, A | —121·0 | 50·6 | —187·0 | —189·6 | | 19·9 | About 1·5 | Colorless. |
| Air | —140·0 | 39·0 | —191·0 | —207 [2] | | | 0·933 | Bluish. |
| Oxygen, $O_2$ | —118·8 | 50·8 | —182·7 | | | 16 | 1·124 | Bluish. |
| Nitric oxide, NO | —93·5 | 71·2 | —153·6 | —167·0 | 138 | 15 | | Colorless. |
| Marsh gas, $CH_4$ | —81·8 | 54·9 | —164·0 | —185·8 | 80 | 8 | 0·415 | Colorless. |
| Helium, He | | | Below —264 [7] (Theor.) | | | 2·02 [8] | | |
| Fluorine | | | —187 | | | | | |

[1] Andrews. Deschanel Nat. Phil., II., 302.
[2] Villard & Jarry. Comptes Rendus, 1895, 120, 1413.
[3] Regnault. Muspratt's Chemie, IV., 1626.
[4] Thilorier. Muspratt's Chemie, IV., 1626.
[5] Fownes. Elem. Chem., 12th ed., p. 584.
[6] Olszewski. Phil. Mag., 1895 (5), 40; 202.
[7] Olszewski. Ann. Phys. Chem., 1896 (2), 59, 184.
[8] Cléve. Compt. Rend., 1895, 120, 1212.
[9] Dewar.

* The literature on liquid air has heretofore been published exclusively in periodical form, but now Prof. T. O'Conor Sloane, A.M., E.M., Ph.D., has written an authoritative book on the subject which is now ready. It is entitled "Liquid Air and the Liquefaction of Gases." It deals with the subject from the earliest experiments to the present time and it includes the most recent developments. It gives the history, biography, and bibliography of the subject, and is withal written in popular style. A special circular will be sent on application. The book is mailed for $2.50 by the publishers, Messrs. Munn & Company, 361 Broadway, New York city. See announcement on another page.

take fire or a cigarette burn if a spark remains in any of these, upon exposing them to the oxygen in the glass of liquid oxygen. Fig. 2 shows the mode of igniting a steel pen or watch spring in the liquid oxygen. It is only necessary to stick the point of the steel into a match and light it, to furnish a sufficient heat to communicate the fire to the steel, when it burns with the same brilliancy as in the ordinary experiment.

Fig. 11 shows a very brilliant experiment. A large flask, 10 or 12 inches in diameter, is filled to the neck with water. Into the top of the flask liquid air is poured. This at first floats, since the specific gravity of liquid nitrogen is 0·885; but as the nitrogen boils away, leaving the oxygen behind, the drops of oxygen begin to sink into the water, since its specific gravity is 1·124. As these drops sink, they are partially turned into vapor, which of course tends to rise through the water. This action communicates a rapid whirling motion to the oxygen, and drives it back again. This may be many times repeated, giving a very beautiful exhibition, since the drops of oxygen may be as large as an inch in diameter.

The magnetic character of liquid oxygen can be exhibited on a large scale in the manner shown in Fig. 1. A test tube with a side tube is filled with liquid oxygen, and a cork inserted. The side tube allows free evaporation to take place. This is then suspended, as shown, by a sling. If an electromagnet be brought near the end of the tube, the tube swings toward and adheres to the pole of the magnet just as if it were a piece of iron. This is, perhaps, the first adaptation of this experiment for exhibition on a large scale.

The enormous force of liquid oxygen is illustrated in Figs. 16 and 17—an experiment which was tried at the request of the inventor of one of our best known guns. A heavy steel tube 18 inches long and of about an inch bore, open at both ends, was securely fastened in a vise. Into the middle of the tube a plug of cotton saturated with liquid oxygen was placed. This was touched off by a taper from a safe distance. The effect of the explosion is shown in Fig. 17, which is a careful drawing from the tube itself.

The practical uses and applications of liquid air have not yet been made, but doubtless the inventive world will find a place and a use for this new power. Already inquiries in this direction are somewhat numerous. The scientific aspects of the matter are of the highest interest. By boiling liquid air in a vacuum, the lowest degree hitherto attained has been reached, and men are brought the nearest they have ever been to the absolute zero. It would appear that, at the point reached, chemical action has well nigh ceased. Even that most active element fluorine, whose chemical affinities at ordinary temperatures are uncontrollable, becomes comparatively inert. It has recently been cooled in oxygen boiling in a vacuum to —210° C. without solidifying. It became a liquid at —187° C. In its liquid form it had apparently no desire to attack anything excepting only substances containing hydrogen, such as turpentine and benzine. Its well known action upon glass entirely ceased. It would seem probable that men have reached in liquid air boiling in a vacuum a temperature quite comparable with that of the spaces between the stars, and that we may realize in a faint degree something of the time when stars and sun have ceased to shine and grown cold.

There are three essentially different methods of measuring low temperatures, all of which are applicable to any temperatures and equally reliable at any temperatures excepting very high ones, at which the instruments would melt. These will be described in the order of their development.

1. The Air or Hydrogen Thermometer.—This is based on the fact that all gases expand and contract at the same rate by heating and cooling. This rate is $\frac{1}{273}$ per degree Centigrade. Now, if a cooling of one degree causes a gas to shrink $\frac{1}{273}$ in volume, it follows that a cooling of 273° would cause a gas to shrink to 0 volume and it would disappear. All heat would be gone from it; 273° C. below zero is therefore the absolute zero, at which there would be no heat, and all molecular motion would cease. Of course this temperature cannot be reached by cooling a gas, since it will turn into a liquid long before all heat is removed from it; but so long as a gas remains a gas, it obeys this law of volume and may be used for thermometric purposes.

Air is the best gas for this use, since it can be most easily procured, and does not liquefy till an extremely low degree is reached.

The air thermometer is considered the most reliable and accurate thermometer for scientific work. Hydrogen may be used in place of air for the lowest temperatures attained, since its point of liquefaction is only 32° above absolute zero, the lowest of any known substance, except possibly fluorine, while air liquefies at 82° of absolute temperature, or 50° C. above hydrogen.

2. The Thermoelectric Couple.—Here an electric current is produced by the difference in the temperature of the junctions of two dissimilar metals, and the current is proportional to this difference of temperature. The thermopile is used with a galvanometer, and the deflection of its magnetic needle is graduated by comparison with a standard thermometer, so that the effect of a difference of 1°, 10°, etc., upon the instrument is known. This is the method used by Prof. Dewar. In his lectures the thermoelectric couple was tested at 0° C. with ice. Its face was then dipped into liquid air, when it indicated —191° C. Upon applying it to the ice, it returned to the 0 point again.

3. The Platinum Thermometer.—It has long been known that the electrical resistance of all pure metals is increased by heating and reduced by cooling. In this respect they differ from alloys and from carbon, the latter of which has its resistance reduced by heating.

A chart of the principal metals prepared from the measurements of Profs. Fleming and Dewar is here reproduced, Fig. 18.

The temperatures from 100° C. to 190° C. are given below, that is, from the temperature of boiling water to that of liquid air. The specific resistances are on the right. It will be noticed that the lines of all the metals given converge toward the absolute zero, from which it is inferred that all pure metals would be perfect conductors at —273° C. It will also be seen that the lines of platinum, aluminum, gold, silver and copper are very nearly straight, from which we infer that the specific electrical resistance of these metals bears a constant ratio to the absolute temperature, or the temperature above absolute zero. The lines of all these, except platinum, slope so slowly that they are not suitable for thermometric uses. That of platinum varies much more rapidly, and a coil of platinum wire may be used to measure temperature. This is calibrated by comparison with the thermopile and air thermometer at known temperatures, and it can then be employed for measurements. The method of its use is simple. It is cooled to the temperature to be determined and its resistance at that temperature is measured. Some record these degrees as "platinum degrees," so that if the relation of a platinum degree to a Centigrade degree should in the future be determined to a higher degree of accuracy, results recorded

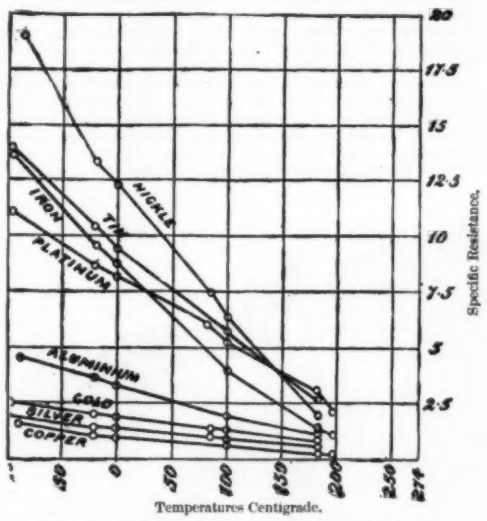



FIG. 18.—ELECTRICAL RESISTANCE OF METALS AT LOW TEMPERATURES.

in platinum degrees would still be easily transformed into Centigrade degrees.

In the use of each of these instruments the measurements are tested through the range which is known, and it is then relied upon through a further range, below this, by a process of extrapolation, that is, its scale is assumed to be unchanged to a certain extent. The agreement of the results obtained by the various methods of measurement is the best possible reason for believing them to be substantially correct.

The writer recently made the following tests at the Adelphi College. By means of a dynamometer the tensile strength of an iron wire was measured. At 58° F. it broke with 15 pounds. At —312° F. it sustained a strain of 22 pounds—an increase of 50 per cent. This leads to the curious conclusion that, as the world grows cold, cohesion will become stronger, and that rocks and metals on the moon are at present much harder than similar materials upon the earth.

Alcohol 98 per cent. pure was quietly frozen in a glass tube in a tumbler of liquid air. On melting it was

FIG. 19.—TUBE SURROUNDED BY CROOKES' VACUUM.

found that the frozen mass softened throughout and returned to a liquid by first becoming of a jellylike consistency, then very viscid, and last sirupy before it became limpid. This would seem to indicate that alcohol resembles iron, glass, wax and similar substances in having no definite melting point, in distinction from substances like ice, which retains its hardness in the interior and melts from the exterior at a definite temperature. The latest data for alcohol are that it is sirupy at —129° C. and stiffens at —130·5° C. (Beilstein). Mr. Benoliel, instructor in electricity in Adelphi College, made several tests before the audience. One of these was to demonstrate the greatly reduced resistance of copper at the temperature of liquid air. A coil of copper wire was fastened to the top of a box into which liquid air was poured, and its resistance was measured as it was cooled. It was shown that the resistance was very greatly reduced by cooling.

In another experiment a pair of platinum plates were immersed in liquid oxygen which was contained in a tube surrounded by a Crookes vacuum. (Fig. 19.) This had been made for the occasion from a design by the writer, with a straight tube 1½ inches in diameter and 7 inches deep, covered by an outer tube, so that there was a space 1 inch wide around the tube. This proved to be a much better form than the ordinary bulb, since it presented much less surface to the air from which evaporation could take place, and thus preserved the liquid oxygen from all boiling. The platinum plates were placed in the liquid oxygen one centimeter apart. The resistance of the liquid between the plates was found to be much greater than if it had been pure water, thus proving that liquid oxygen, though a magnetic substance, is still an insulator. Prof. Dewar concluded from experiments with an induction coil that its resistance would be about five times that of air, but in this experiment the actual resistance was shown to the audience.

Doubtless the test which can now be made at extremely low temperatures by the agency of liquid air at atmospheric pressure will cause a revision of some of the data at present received as correct.

## HOW CRIPPLES ARE MANUFACTURED IN SPAIN FOR THE PARISIAN MARKET.

A WRITER in the Journal d'Hygiène, says the National Druggist, in reviewing the work of the various associations for the prevention of cruelty to children, the suppression of crimes against childhood, etc., which of late years have sprung up and flourish in France, among others, gives the following instance of the atrocious treatment of a child. The recital reminds one of some of the horrors depicted by Victor Hugo, in his "Les Miserables," "L'Homme qui rit," especially:

"Without having recourse," says our author, "to cases which are fortunately rare, I will confine myself to examples which are comparatively common samples of the crimes against childhood.

"A little girl of nine years had been the object of such brutality on the part of her parents, that both father and mother were finally arrested, and the wounded, tortured child was sent to a hospital, where the physicians were compelled to amputate one leg at the thigh. The mother, having served a term, on being released from prison, sought her daughter, and finding her with one leg the less, suddenly seemed inspired with a tenderness toward her offspring hitherto unknown. The child, thus crippled and disfigured, had become to her a veritable godsend, a fortune dropped into her arms from the skies—she would take good care that it did not escape her.

"'Mendicity—the life of a beggar'—she had said to herself, 'what a beautiful career! But how hard to enter these days, since there has arisen a class of people who meddle themselves about what does not concern them, and who have undertaken to "suppress begging." One can no longer stretch out an honest hand in the streets without these people seeing the "fruits of labor" fall into it!

"'The "fruits of labor," I ask you, what has that to do with it? Ah, how happy are those who possess a good infirmity—one that is real, and openly and easily seen! Come, then, we will let the good people offer some of these "fruits of labor" to a poor little girl, that has but one leg. *Tiens*—it would be still better if the filette had no leg at all. If I only had a child *cul-de-jatte*—what fortune!'

"You have seen these *enfants cul-de-jatte*, strapped into their little boxes on wheels—little monsters with atrophied limbs—and, in spite of all that you have been told of the 'tricks of mendicity,' here is a worthy object, you say to yourself, and you never fail to drop your alms into the little box. You were humbugged—'done for'—once more.

"The '*cul-de-jatte*' is an industrial product, an article of commerce, manufactured in Spain, at Tolosa, some 22 kilometers (13 miles) south of San Sebastian. Agents of the concern, or parties at work for themselves, with a view to speculation, travel all over the country on the search of crippled or infirm children, the club-footed being regarded as the choicest subjects. The child is taken, usually at the age of seven or eight years, and is placed in the hands of the manufacturer of '*cul-de-jatte*,' a sort of 'mender on the reverse' (*rebouteur à rebours*), who, in the course of a couple of months' treatment, engages to twist and curl the arms to atrophy and dry up its limbs, and to make of it a monster so frightful that it will make *sous* rain into the pockets of those fortunate enough to become its owner.

"Once a year the '*padron*,' or showman in charge, assembles his caravan at Tolosa and starts northward over the Pyrenees, the little carriages, each having strapped therein a '*cul-de-jatte*,' making short stages daily, skirting the south of France, until Paris is reached, about the time when the Fair of Spiced Bread (*foire aux pains d'épices*) commences. Every evening, the amounts received by each of the miserable little creatures are poured into the hands of the *padron*. The parents are allowed a small sum—15 to 30 francs a month, according to the success of the little cripple.

"The trade must be a good one, since, in 1887, the Ministry of the Interior, which tried in every way to suppress the odious traffic, estimated the number introduced each year, from Spain, at 400. In one of the late batches was one little girl.

"You may say that this cripple factory is not in France, but in Spain, that, therefore, we cannot reach it, and your *amour propre* is nearly satisfied with the thought. True, we have not yet attained the *cul-de-jatte*, but the curse is none the less among us. Cruelty to children, crimes against childhood, are rampant here. In some parts of France they are almost epidemic!"

The author then goes on, in a style like that of Hugo, to call attention to the little fellows that one so frequently sees in Paris—the little Savoyard chimney sweeps, covered with soot from head to foot, yet whom no one has ever seen sweep a chimney—because, as the author points out, Parisian chimneys are so constructed that it would be impossible for a body as large even as the diminutive sweeps to enter one of them. The boys are, he maintains, children obtained by a certain asso-

ciation or company of men, who make annual trips to Savoy for the purpose, and who are first hired out to the vintagers of certain wine-making departments, then brought to Paris, sent on the streets ostensibly as chimney sweeps, but really as beggars, and each of whom is expected to bring to his *padron* (each of whom has charge of eight to ten boys) from 30 to 40 cents every night. Failure to bring the amount is followed by horrible punishments, the bruises and wounds inflicted in the course of which make the boys more valuable as beggars, because the more pitiable objects. If one-half that the author states be true—and he claims to have irrefutable evidence of the truth of every charge—the government of France cannot any too soon use its whole power to suppress the terrible traffic.

## ENGINES OF THE STEAMSHIP "ULTONIA."

IN our engravings we publish three perspective views of the twin-screw engines of the steamship "Ultonia." This vessel is said to be the largest that has been built in the district. She is arranged for carrying cattle, being fitted especially for the purpose. Her length over all is 513 feet, her extreme breadth 57 feet 4 inches and her moulded depth 37 feet.

The machinery has been supplied by Messrs. Sir Christopher Furness, Westgarth & Company, Limited, Middlesbrough-on-Tees, and is of their standard type which they have applied with considerable success in a number of vessels. The engines are of the three-stage compound type, and, as will be seen by the illustrations, are of the three-cylinder and three-crank description. The cylinders are 23½ inches, 38½ inches and 68 inches in diameter by 48-inch stroke. The indicated horse power is 5,500. Each engine is separate and self-contained, the starting platform being between the two sets. The machinery is designed for a working pressure of 200 pounds to the square inch, and is in accordance with Lloyd's requirements. The engines also are so constructed that a Board of Trade passenger certificate may be obtained if required at any time, while the boilers have been built under Board of Trade survey for the same end. The high pressure cylinder has a piston valve, the intermediate and low pressure engines having ordinary double-ported slide valves. A separate liner of hard cast iron is fitted to the high pressure cylinder. The piston valve also has a cast iron liner. Steam is taken in the center of the piston valve. Water traps are fitted to the intermediate and low pressure valve chests draining to the hotwell. The high pressure piston rod and valve rod stuffing boxes have a special metallic packing of Messrs. Furness, Westgarth & Company, known as the Cleveland packing. The pistons are of box castings, well ribbed. No tail rods are fitted, and the junk rings are especially deep. The high pressure and intermediate pistons have Ramsbottom rings, while the low pressure piston has Buckley springs and rings. Joy's patent assistant cylinder is fitted to the top of each low pressure valve-rod. The piston rods are of forged iron, 7 inches in diameter. The crossheads are iron forgings with cast iron adjustable shoes, the head-going shoes having white metal strips. An Aspinall governor is fitted to each engine. The connecting rods are 9 feet long between centers, and are of forged iron. The crankpin bushes are of cast steel fitted with white metal. The valve gear is adjustable throughout, and has double bar links and cast iron eccentrics with wrought iron straps having cross liners. The reversing gear is of the all-round type, with steam and hand motion, and there are the usual turning engines.

Each engine has six cast iron box standards with forked bottom ends, as shown in our illustrations. The separate slide plates fitted to the columns have water circulation behind them in the head-going slides. Brackets are cast on two of the back columns for supporting the condenser and for carrying the pumps and levers. The bedplate of each engine is in two box-shaped castings, well ribbed and strengthened and attached to the engine bearers in the vessel. Each bedplate has six main bearings fitted with cast iron bushes 15 inches long and lined with white metal. The wrought iron keeps are held down by steel bolts. Each set of engines has a cylindrical steel condenser as shown in the illustrations. There are cast iron waterways at each end. The tubeplates are of Muntz metal 1 inch thick, and the tubes are solid drawn of brass ¾ inch external diameter and 18 B. W. G. They are packed with cotton and have screwed glands. All bolts and nuts in the condensers subject to sea water are of brass or Muntz metal. The total cooling surface in the two condensers is 7,000 square feet. Water is circulated twice through the tubes, and arrangements are made so that the ballast pump can be used for the purpose if required. Each condenser has a single acting air pump 23 inches diameter by 27-inch stroke, and having metallic valves. There is a centrifugal circulating pump to each condenser. They are arranged to draw from the bilge and discharge directly overboard if required. Two feed pumps, 4 inches in diameter and 27 inch stroke, are fitted to each main engine. They are arranged to discharge through a filter and feed heater, or direct to the boilers, as may be desired. The rams are of cast iron cased with brass, and have the Cleveland metallic packing. Each set of engines has two single-acting bilge pumps 4⅛ inches in diameter by 27 inch stroke, the rams being solid forgings cased with brass. There are two single-acting sanitary pumps, each 4 inches in diameter by 10 inch stroke, driven from the main engines by the air-pump levers. There are also a duplex donkey pump, and a duplex ballast pump having a capacity of 200 tons per hour.

The crank shaft is of forged iron. The diameter of the shaft is 13¾ inches, the crankpins being the same diameter, and 16 inches long, and are of forged steel. Each shaft is in three interchangeable pieces. The cranks are at equal angles, the high pressure crank leading. The propeller shafts are iron forgings 14 inches in diameter and cased with ¾ inch brass. The tunnel shafting is of iron, 13 inches in diameter, increasing to 13¼ inches at bearings. The shaft carriages are filled with white metal at the bottom half. The thrust-blocks are on the horseshoe principle and lined with white metal. The steam tubes have lignum-vitæ strips. The propellers are four-bladed, the bosses being of cast iron and the blades of manganese bronze. The bolt holes for securing the blades to the boss are oval, so as to allow of alteration of pitch.

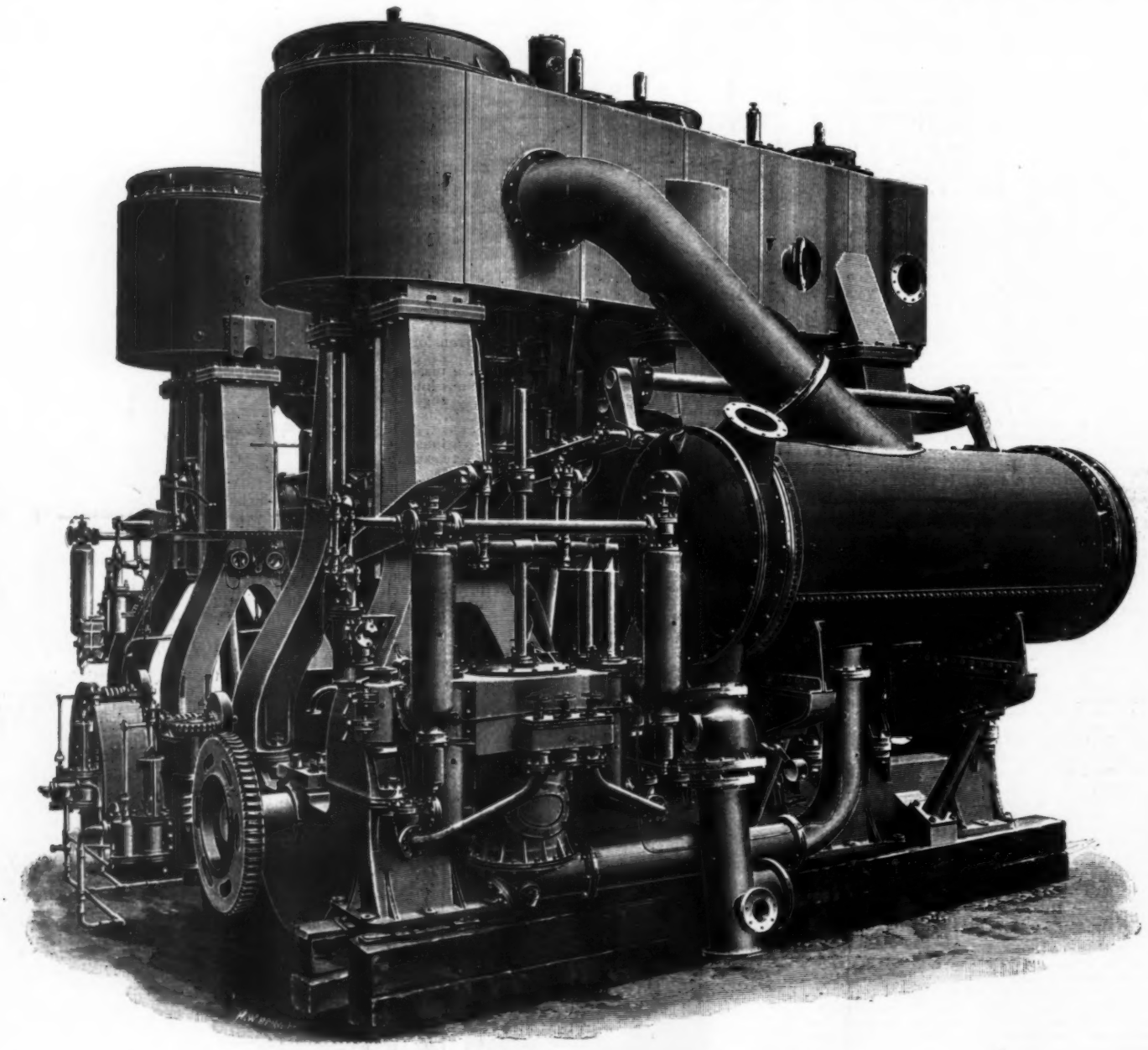


FIG. 1.—ENGINES OF THE STEAMSHIP "ULTONIA."

The main steam pipes are of wrought iron, the smaller pipes being of solid drawn copper.

There are five single-ended return-tube boilers, each 14 feet 4⅛ inches mean diameter and 12 feet long. They are made in accordance with Lloyds and the Board of Trade regulations for a working pressure of 200 pounds per square inch. Each boiler has three furnaces 3 feet 6 inches in diameter with separate combustion chambers. The furnaces can be taken out without removing the front plate. The circumferential seams are double-riveted, and the center seam is treble-riveted. The horizontal seams are butt-jointed and treble-riveted. All plates and rivets are of Siemens steel, the tubes are of iron and the total heating surface is 12,000 square feet. Howden's forced draught is fitted, there being two 84 inch fans driven by separate engines having cylinders 7½ inches in diameter. There is one funnel 11 feet in diameter, ⅜ inch thick at bottom and ¼ inch at top.

The vessel, which has been built by Messrs. Swan & Hunter, of Newcastle, is, as stated, arranged for the cattle trade. Above the upper deck is a shelter deck extending the whole length of the vessel, and provided with fittings of the latest type for carrying cattle. At the fore end of the vessel, on this deck, accommodation

is provided for the crew and firemen, and at the after end for a large number of cattlemen. Above the shelter deck is a long bridge extending out to the full width of the vessel, and which, like the shelter deck, is fitted up for cattle. On the two decks the ship will have accommodation for 800 beasts. Above the bridge in a large house, round the engine and boiler casings, are situated the saloon and rooms for officers, petty officers, engineers, foremen cattlemen, etc. Over this structure is a house containing the master's room, chart room, and wheel house, and over all the navigating bridge. The deck machinery has been supplied by Messrs. Clarke, Chapman & Company and the steering gear and rudder brake by Messrs. J. Hastie & Company, Greenock, who also supplied the Wilson & Pirie patent elastic quadrant. Three large refrigerating engines made by the Liverpool Refrigeration Company have been fitted at the forward end of the bridge. The whole of the lower 'tween deck forward is insulated for the carriage of chilled beef, bacon, etc.

The steamship "Ultonia" has now been at sea for some months, and has made several passages across the Atlantic. She has been in a great deal of the recent bad weather, and has behaved admirably, proving herself to be a most satisfactory and comfortable boat at sea. She has put out cargoes of over 11,000 tons deadweight, including bunker coal, and steams 12 knots on 56 tons of coal per day. It is anticipated that she will steam much better under favorable circumstances, but as remarked above, she has hitherto had nothing but bad weather.

We are indebted to Engineering for the above description and engravings.

[Continued from SUPPLEMENT, No. 1216, page 19392.]

## THE LOGICAL ARRANGEMENT OF THE MOTIVE POWER OF WARSHIPS.*

By GEORGE W. MELVILLE, Engineer-in-Chief U. S. Navy.

A MUCH more serious objection to the use of triple screws than the multiplicity of engine parts is found in the greater intricacy of the piping plans and in the increased number of valves required. This objection is serious. Our twin screw warships are complicated enough at best. This disadvantage has been reduced somewhat, however, by several simple methods. The use of electrically operated auxiliaries has done much in this respect, especially as regards piping outside of the machinery space. Our piping plans are very carefully studied, and are so designed and arranged as to reduce the number of valves to a minimum and to render plain to the engineer the leads of all pipes. All valves are marked plainly to show the connections. Many of them indicate as well the amount of opening of the valve. As a result of this care in the laying out and installation of piping and valves, mistakes in the operation of the valves are made almost impossible and undue intricacy of the piping plans is avoided. This absence of complexity is especially marked when comparison is made with some of our earlier twin screw ships.

The growth in number of auxiliary engines owing to the employment of three main engines is another disadvantage of the triple screw system that is much more apparent than real. Ordinarily, there is no increase in the number of auxiliaries in use, only an increase in the number available for use; and, as a rule, these uneconomical auxiliaries are worked much more nearly at their rated capacity and are thus considerably less wasteful of steam. Our experience has been that the auxiliary machinery gives most of the trouble on board ship, and our vessels have been more frequently disabled on account of the failure of these small engines than from any other cause due to the machinery. A larger reserve power in this, the weak part of the machinery, is too great an advantage not to be well worth its cost.

The increase in engine room force required with the three engines is not excessive, being twelve men at the most. This cannot be considered a disadvantage for warships. The added staff consists entirely of skilled mechanics, and these men are especially useful in making repairs while under way. Our recent war experience tends to show the imperative necessity of some such mobile reserve for the maintenance of a vessel, constantly under way, in a condition, at all times, of thorough efficiency. With this increase, there is always some one at hand to take the place of any man overcome by heat or sickness, and crippling of the crew as well as of the machinery is guarded against. I repeat that the increase in the engine room force necessitated by the adoption of three propelling engines cannot be counted a disadvantage in men-of-war, under war conditions.

The formation of the stern post and rudder is made somewhat complicated by the use of the central propeller, but not more so than in any single screw merchantman, and I apprehend that this disadvantage will not be given great weight by any designer.

To obtain a proper conception of the advantages of triple screw propulsion, it is necessary to consider, also, the latitude afforded by this system in the methods of running the ship under cruising conditions, since either one, two, or three screws may be used. There have been many trials of triple screw ships under each of these methods of propulsion, and it may be interesting to give a few of the results which have not hitherto been published so far as I am aware. Taking a vessel of, say, 12,000 tons, 23,000 horse power, and 22 knots speed, when all engines are used at full power it is found that:

1. The power required to drag one screw, uncoupled from the engine and left to revolve freely, is 150 horse power at 10 knots; 600 horse power at 15 knots.

2. If coupled to the engine, at 10 knots speed the power absorbed in dragging is slightly in excess of 300 horse power.

3. If two screws are dragged, the loss from drag is practically double what it would be with one idle screw for the same speed of the ship.

4. The loss in power due to condensation in an engine (not the result of expansion of steam in the cylinders, but attributable directly to the heating of the cylinder walls) is almost exactly one pound of steam for each horse power of the maximum power for each engine. This figure is approximately correct for all speeds, increasing slightly for the lowest speeds. It applies to jacketed engines.

5. With three equal screws the center propeller has not sufficient area to give economical results when used alone at speeds above 8 knots. With three equal screws, the use of the two wing propellers alone can be depended on to give a considerable gain in economy for all speeds from 8 to 17 knots inclusive. These results have been gathered from fully authenticated trials, not only of our own ships, but also of triple screw ships in other navies.

All screws were practically equal in disk area in the trials from which these results are obtained.

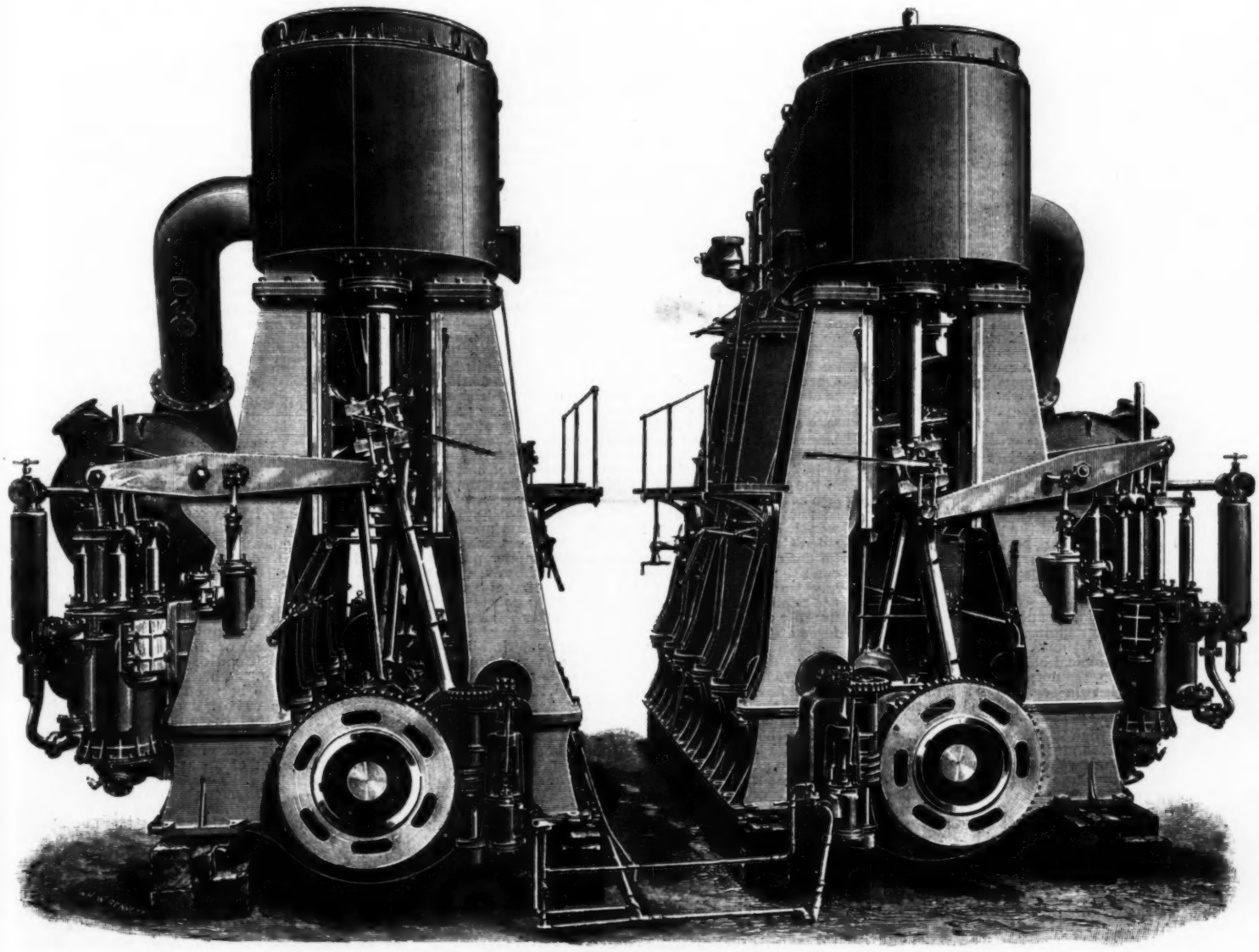


FIG. 2.—ENGINES OF THE STEAMSHIP "ULTONIA."

With these points known, the problem of the design of triple screw ships is greatly simplified. The disadvantage of the drag of a screw is measured, and the advantage of the fitting hitherto adopted, which provided for the disconnecting of any idle screw from its engine, is clearly developed. The necessity of giving sufficient disk area of propeller is, as was to be expected, prominently shown by the failure to secure economy with one engine in use, except at the very lowest speeds.

The value of economical engines is so universally recognized to-day that it seems almost unnecessary to mention it, but this value is, in a warship, far greater than the mere saving in the coal bill, though that is an important item. The matter of economy in the use of coal may make all the difference between victory and defeat. Coal endurance limits the radius of action of the ship and determines definitely the scope of her operations. Of course, we can, as we did recently, in two cases, assist a monitor across the Pacific Ocean in case of need, but that tardy reinforcement might have been too late. Economy at the engines increases the speed of these reinforcing ships where that economy can be gained without a reduction of bunker space; it increases the potential value of each pound of coal, and ten per cent. may often make the difference between success and failure. If this economy were measured in dollars alone and not from the military point of view, it might be proper to consider the question whether three engines have a greater first cost than two of the same total power, but economy means more

* Paper read by Harold P. Norton on behalf of the author before the British Institution of Naval Architects.

than that. It means victory, and it is for this that men-of-war are built.

If three screws are to be fitted to a warship, and the design is to conform to the conditions of economical propulsion obtaining on these vessels, as shown by our present knowledge of the effects of three screws upon propulsive and engine efficiency, there appear to be but two practicable arrangements. The central engine should be considerably more powerful than either of the wing engines or it should be considerably less powerful. This follows from the fact that a propeller design which will give in one screw sufficient area for the ordinary cruising speeds up to 12 knots is nearly impossible if the same screw is designed to be worked as one-third of the propelling system for the highest speed of the ship. The proportions of the screw must be changed to suit the latter conditions. It is evidently not wise to use as much as two-thirds of the full engine power for cruising at one-tenth power. The use of three equal engines is therefore out of the question as far as comparative economy goes. If a small center engine be used, it would be practically an auxiliary. A very large screw necessarily being fitted to secure a fair propeller efficiency at low speeds, when the small engine alone would be used, it would be of practically no value at the highest speeds. I consider, therefore, that it would be far better practice to use a large center and two small wing engines, in which design under no conditions would there be a useless engine. Of course, either of these plans involving the use of two different sizes of engines on the same ship is disadvantageous, but this disadvantage is not so great as a casual view of the conditions would seem to indicate. Engines do not break down in service. Careful designs for the maximum power insure good working of the machinery. Accidents to the engines are extremely rare, and are due almost invariably to some defect in a seemingly unimportant detail. The engine itself, so far as its large parts are concerned, does not break down, and a supply of the lighter spare parts provides for all emergencies such as are ordinarily met. On the other hand, it is well to note the many advantages due to the use of different engines. There is, in particular, much to be said in favor of the plan of installing small wing engines in a triple screw ship. It is a fact that commanders of our ships hesitate, as naturally they should, to enter or leave a port with only one screw in use. They desire to retain the practical advantages of handiness accompanying the use of twin screws. It is, further, a fact that ships which ordinarily cruise at speeds of from 14 to 16 knots we have found to make better speed, in time of war, than ships of the same class but of lower cruising speed. These conditions, combined with the proved efficiency of the use of the wing engines at speeds up to 17 or 18 knots, have been, with us, the determining factors in causing the adoption of designs involving the use of the smaller wing engines. It has been found advisable to fit economical machinery for cruising at speeds as high as 16 knots. While engines which will be most economical at this speed will not be the most desirable, in this respect, for a speed of 10 knots, they will retain considerable advantage over any other system, in the reserve which will be ready for instant use.

The problem of the design of the propellers to give a proper efficiency for low speeds, and to be good also at the highest speed, offers, in this system, no difficulties. The reduction in the size of the wing engines below what would be necessary if three equal engines were used effects a saving of about 200 horse power, or its equivalent in steam, due to the decreased condensation on account of the smaller engines. This figure applies exactly to our recently designed 22 knot armored cruisers. The ship is economical at all the ordinary cruising speeds from 10 to 17 knots. The tactical advantages of working with twin screws are retained at all speeds high or low. It has been pointed out that the decrease in size of screw is especially advantageous for the wing screws, and that it is advantageous, on account of the superior propulsive efficiency of the screw working in the following wake, to have a large power on the center engine. These conditions are especially well fulfilled by the use of the smaller wing engines.

To reduce the engine room space, it is advisable to place engines abreast in the ship. It is also a great advantage to arrange the engines in this way, as it makes possible the placing of a part of the boiler power abaft the engine, which gives easy solution to all problems connected with the change in trim due to the use of light water tube boilers, and also reduces vibration by placing the engines in the strongest part of the ship; in fact, the center and most powerful engine is exactly at the point of greatest resistance of the hull to vibration. By using smaller wing engines it is also easier to arrange the engines abreast than it would be to install twin screw engines of the same total power. This follows from the lozenge shape of the space available for the engine rooms beneath the sloping protective deck and above the rising bottom of the ship. Again, but one screw is dragged with the two engines in use. This screw is a large one, it is true, but the drag is probably not so great as it would be with two smaller screws of the same total power.

It is, also, regarded as an advantage for this system that there is always one-half the full power available in case of accident. The center engine is seldom used, and our experience goes to show that it is always in a condition of very good efficiency. The customary employment of the smaller wing engines insures ease of making the regular repairs. It is but fair that I should state that, with its very large screw, designed for transmitting about half the total power at full speed, the use of the center engine alone may prove slightly more economical than that of the wing screws for a speed of about 10 knots, this superior efficiency following from the working of the screw in the following wake. I do not expect, however, that the center engine will often be alone employed, as the maneuvering qualities and general handiness of the ship are so much improved by the use of two screws at all times. It should, however, be pointed out that the handiness will be retained at full power and will not be affected badly by the reduction in the size of the wing engines.

In a word, the arrangement of triple screw engines, with approximately one-half the total power placed upon the center engine and approximately one-quarter on each of the wing engines, seems to fit a warship and its conditions remarkably well.

Ramming and torpedoing would lose much of their danger with the small engines outboard. There is a certain prejudice among naval officers against any system that shows so plainly as do triple screws the enormous amount of power installed in the ship and so seldom employed. These officers would possibly prefer to imagine all the power in use, even when knowing, as they all certainly do know, that frequently not ten per cent. of the total power is actually being developed.

The loss from drag of an idle screw is plainly seen, but they forget the loss in the engine cylinders from condensation, which is often much greater. Not to employ ordinarily the reserve power plant increases the value of this reserve as well as the economy. It may appear unwise to install a plant that is so seldom used, yet when the power is wanted it will be wanted badly, and at such times every pound of coal in the bunkers may be worth a ton at ordinary times.

The use of two screws with two engines upon each shaft has not been considered as an alternative to the use of triple screws. This arrangement, with its four engines, has nearly all of the disadvantages attendant upon the use of three screws, with very few of their advantages. Further, it presents the grave tactical disadvantage which was developed so fully in the cases of the "Brooklyn" and "New York" at Santiago. These vessels were fitted with four engines working twin screws, the forward engines being ordinarily uncoupled. This system was designed to insure economical running at low speeds; but it was impossible to couple up the forward engines without stopping the ship. During the battle of Santiago, stopping the ship for the fifteen minutes necessary to couple up the engines would have been fatal. On the contrary, in the case of the "Minneapolis," the center screw was coupled up while the two wing screws were driving the vessel at a speed of 17 knots. This was done when the ships of Admiral Schley were sighted off Santiago and before the identity of his fleet had been established. It is a great advantage that full power can always be applied on a triple screw ship without stopping. Such conditions would surely have been very valuable to the "New York" at Santiago.

It may naturally be inquired why the superior efficiency due to the use of triple screws has not led to their general adoption in the merchant marine. Triple screws undoubtedly would have been used in that service if the conditions obtaining were the same as those existing in the navy. Merchant vessels, however, instead of running at a variable speed, are always worked at their full power, and there would be consequently no advantage to their owners in fitting machinery capable of working economically at low speeds. The stroke of engines in these vessels is, also, not limited by a protective deck, and it is always possible with them to obtain the great piston speed necessary for economy by increasing the height of the engine. We see, therefore, that two of the main reasons for the use of triple screws in men-of-war do not obtain in the merchant service. Added to this must be the fact that the cost of building and installing three engines when not all of the same size is considerably greater than that of two engines of the same total power; and also that the cost of maintenance due to the larger force required would be considerably increased. From these considerations, it would appear that triple screws may not be desirable for the merchant service under present conditions of size and speed. I think, however, that any transatlantic line which would definitely adopt the triple system would be patronized by a considerable number of persons because of the greater security afforded by its use.

The statements I have made as to the desirability of using three screws on war vessels, and the fact that they are being used to so great an extent in the Continental navies, will naturally lead the thoughtful student to wonder why they have not been adopted, to some extent, at least, in British vessels. This feeling will be the stronger from the fact that British engineers are justly considered to be thoroughly progressive and abreast of the times with respect to every feature that would tend to an increase in the efficiency of vessels.

It has occurred to me that whatever other reasons may have caused this non-use until now of triple screws on British vessels, one feature of the case, at least, may serve as a partial explanation. I am led to this belief all the more from the fact that it agrees with the experience of all designers with respect to some forms of marine machinery, which, while apparently very peculiar, are the best adapted to the particular cases where they have to be used, viz., the exceedingly light draught steamers required for certain river service.

Yacht designers are very familiar with the fact that vessels designed for general cruising on the English coast are very different from those for general use on the coast of the United States, due to the fact that in England there is everywhere an ample depth of water, while in the United States the reverse is the case.

In just the same way we in the United States are restricted in the draught of our war vessels to about twenty-four feet, while the large British ships can, and do in some cases, draw about twenty-seven feet. As a consequence of this radical difference in the circumstances under which large powers have to be applied, the problem of the number of propellers is presented to the designers on the two sides under a different aspect, and I am inclined to believe that this has had a great deal to do with the fact that British designers have not paid much attention to three screws thus far. Had they been compelled to face the problem of putting large powers in light-draught hulls, I think they would have been driven to a consideration of the advantages of three screws, and probably would have taken hold of the matter with their characteristic energy.

Let me add, in conclusion, that I have given this subject of triple screws very careful study, and I believe that for war vessels their use is thoroughly logical.

Further than that, I believe that, although contrary to the generally accepted idea of duplication of parts as far as possible, the plan which I have suggested for dividing the power between one large central engine to develop about half the power and two smaller wing engines, each of about one-quarter power, will give the best results, and is likely to be the system that will finally obtain general adoption.

### THE CASE OF TRIPLE SCREWS.

| THEIR ADVANTAGES. | THEIR DISADVANTAGES. |
|---|---|
| Smaller engine parts. | Greater number of parts. |
| Greater ease of overhauling. | Greater number of valves and pipes. |
| Greater accuracy of adjustment. | Greater number of auxiliaries. |
| Lack of vibration. | Increased engine room force. |
| Subdivision of power. | Loss of power due to drag of idle screw. |
| Increased (probable) available power. | With center engine alone used, the loss of the tactical advantages due to twin screws. |
| Increased ease of protection. | |
| Increased handiness when partly disabled. | |
| Smaller watertight compartments. | |
| Smaller propellers. | |
| More efficient propellers. | |
| Less peripheral speed of propellers. | |
| Less screw friction. | |
| Increased revolutions of engines. | |
| Decreased loss from cavitation, the word being used in its broadest sense. | |
| Increased efficiency of the screw working in the following wake. | |
| Decreased danger to propellers in ramming. | |
| Decreased danger to ship that is rammed or torpedoed. | |
| Shorter propeller shafting. | |
| Decreased racing of screws. | |
| Freer design of stream lines. | |
| Freer access of water to screws. | |
| Increased piston speed and economy. | |
| Decreased total size of cylinders. | |
| Decreased weight of machinery. | |
| Decreased condensation in engines at all—especially at low-powers. | |
| Adaptability to light draught. | |
| High ratio between stroke and diameter of cylinders. | |
| Less glacis plating required. | |
| Ease of propeller design. | |
| Latitude of engine design. | |
| Great gain in economy at low powers. | |

### THE CASE OF THE PROPOSED SYSTEM OF TRIPLE SCREWS WITH SMALL WING ENGINES.

| ADVANTAGES. | DISADVANTAGES. |
|---|---|
| It fits the ship. | Two sizes of engines in same ship. |
| Ease of installation and design. | Increased cost of building. |
| Great gain in economy at all speeds. | Increased number of spare parts necessarily carried. |
| The tactical advantages of twin screws economically retained. | |
| Engine room space is reduced. | |
| The powerful center engine has a most economical screw working in following wake. | |
| The vibration is minimized. | |
| The loss from drag of screw is minimized, one screw only being dragged. | |
| Small size of working parts. | |
| Two independent plants, each capable of economical propulsion up to 15 knots speed. | |
| Small size of working parts with maximum ease of repairs. | |

**The disadvantages are few, and, from a broad standpoint of military excellence, they are unimportant. The advantages are many, including better design and installation, greater ease of maintenance, and greater efficiency at all speeds. I consider this the logical arrangement of motive power on high-powered warships.**

## THE SQUID IN ART.

IN a recent issue of The American Journal of Archæology, Mr. William Hayes Ward presents an article having the general title "Oriental Antiquities." A Hittite cylinder seal of magnetic iron has been found on the Mediterranean coast of Syria, on which are engraved gazelles, a cow and a calf, a lion, lionesses, deer, and a squid or cuttlefish. The presentation of the cephalopoda in art is curious and will be novel to many. Mr. Ward shows, however, that it was not an uncommon object in Oriental glyptic art. "The cuttlefish," he writes, "is quite familiar as depicted on the early Mycenaean or Aegean pottery. It appears on vases from the island of Ialysas, also from Aeolis and Mycenae itself." This style of decoration dates back at some time between 1000 and 1500 B. C., and free use was made of both floral and marine forms.

One might say that the unknown potter of the remote past used certain decorations as did Bernard Palissy. Certainly the presentation of the cuttlefish indicated the work of an artist who was acquainted with marine zoology. The cuttlefish, as shown in the print, a copy of a fragment of the Mycenaean vase, is treated in the clearest manner, and the artist, though giving full scope to his fancy, has not departed from the original form. It is so excellent that Prof. Verrill, our best authority in cephalopods, would have at once classed it as belonging to the Mediterranean Sea.

The cephalopod on the supposably Hittite cylinder is of a different species, and resembles somewhat in form the octopus Bairdii. A closely related cuttlefish, as to shape, is, however, found on the Mediterranean.

In Japanese art the cuttlefish figures. The pictures of the cephalopods, as the Japanese drew them, were at first questioned as to their truthfulness. But the Japanese artist, when animals, birds, or fish are to be outlined, is always remarkable for his realism. The Japanese cuttlefish was gigantic. It is only within the last thirty years that naturalists have found that the Oriental artist was perfectly correct. Off the Labrador and Newfoundland coasts cuttlefish have been thrown ashore with a total length of 44 feet.

If the artist of to-day, says The New York Times, were bold enough to introduce the cuttlefish in mural decoration, it would be of help for him to know that some of these smaller cephalopods are beautifully colored.

**P. Q. Keegan** concludes that a blue flower is unproducible in species which contain or are capable of forming phlobaphenic tannin, no matter what the development of the inflorescence may amount to, and that a blue flower is more likely to be produced in a species having a gamopetalous corolla or perianth, and, therefore, liable to evolve by higher oxidation a certain quantity of a high oxybenzoic acid. He also thinks that in species wherein the tannin natural to the organism is iron-greening and non-phlobaphenic, a blue flower may possibly be producible in a polypetalous corolla, provided always that the petals or perianth be large relatively to the height of the plant and to the size and robustness of its stem and leaves; in this case it is uncertain whether gallic acid is necessary for the production of the effect, but an alkaline compound of an oxybenzoic acid would seem to be indispensable.—Natural Science, 14, 143.

## ENGINEERING NOTES.

**There are** 3,311 miles of railways open for traffic in Japan, all of which have been constructed during the last thirty years. Almost the whole of this mileage is of single track. The average charge per passenger per mile is slightly over one sen—one farthing.

**England finds** it impossible to dock her biggest battleships outside of Europe. The Hong-Kong Dock Company has refused to take the risk of docking the Victorious, as the battleship is only six inches narrower than the dock entrance. She must therefore return to England to be cleaned, unless she can get into the Malta dock. The Victorious, it will be remembered, ran aground at the entrance to the Suez Canal on her way to China, and was floated again with difficulty. The reason given at the time was that her anchors were not big enough to hold.

**The large** orders for locomotives booked at the present time presage a season of unusual prosperity for American locomotive builders. Recent orders from the Trans-Siberian call for 81 engines. Sweden orders 20. The French State Railways 10. Egypt 15, and the Midland Railway of England 30. The exceptional equipment and facilities of the American locomotive builder facilitates rapid work, and therefore early deliveries of their product, which is one of the prime reasons why these foreign orders come here. The steady growth of the export of locomotives is shown by the following output: 1896, 312; 1897, 348; 1898, 580. At this rate of increase the foreign trade will soon equal home orders.

**A** 5-inch Brown segmental tube wire-wound gun, being made at Birdsboro, Pa., for the government, is being tested by government officers at that place, up to 500 rounds. The gun weighs 3½ tons and is 19 feet long; and up to the present time the maximum pressure exerted has been over 30,000 pounds per square inch, imparting a velocity of nearly 3,000 feet per second to the projectile. Twenty-five of these guns have been ordered, and twenty-five others of 6-inch caliber. These last weigh 10 tons each and are intended for coast defense. A 10-inch gun of the same type is also being built at the Scott Works, in Reading, Pa., to be tested in July. The 6-inch guns will cost $10,000 each, according to the press accounts.

**General McGlashan**, of Truckee, has completed his test of substituting structures of wire netting for the wooden sheds on the line of the Central Pacific Railroad across the Sierra snow belt with satisfactory results, and will submit to the Southern Pacific Company a proposition to adopt that method of keeping their roadbeds clear of snow during the winter. The tests made showed that scarcely any snow sifted through the interstices of the wire netting during the heaviest storm of last winter. The inventor claims that by the use of wire netting not only will the annual loss from fire be averted, but its substitution will enable tourists to obtain an unobstructed view of the fine scenery while crossing the Sierras. The building of a mile of wooden snow-sheds costs $78,000, and their construction of wire-netting would be much cheaper.—Boston Transcript.

**A pontoon** barge to carry steel canalboats will probably be built late this year by the Cleveland Steel Canalboat Company, Charles E. Wheeler, secretary and manager, of Cleveland, O., says Engineering News. As designed this barge will be 360 feet long, 45 feet beam, and 24 feet deep, with double bottom and sides for water ballast. This barge would carry six canalboats in two rows of three each, and these boats would be floated in at the stern, while the barge is partly submerged; the opening would be then closed by gates and the barge pumped out. The estimated cost of the barge is $125,000, and, with minor alterations, it could be converted into an ore carrier. It is intended for carrying canalboats between Cleveland and Buffalo; and the trip is to consume forty-five hours, at the rate of about four miles per hour, with a steamer and three consorts. At present these canalboats are towed through Lake Erie in fleets; but this navigation is seriously interfered with by storm and ice, and the new barge is supposed to be able to make the passage in any weather.

**The new** railway which is in course of formation on Vesuvius is under the direction of Mr. Fell, a son of the nonagenarian who constructed the original railway over Mont Cenis, which was the first of the Italian mountain railways, and has since the opening of the tunnel been transferred to the Righi. It is risky to undertake improvements in the neighborhood of Naples, for Mr. Fell and his colleagues have been threatened with personal violence by the guides, who think that their trade will be seriously interfered with by the line. The vast addition to the number of visitors will, instead of injuring the guides, probably increase their profits and make their work far less arduous. The question, however, arises whether the line can be considered as a permanent way. Vesuvius of late years has been exceptionally active, as if resenting too much familiarity with its terrors. The carriage-way could not be used, owing to the débris which blocked it, and the observatory and other new buildings were threatened with destruction. A railway under such conditions is exposed to many dangers.—The Architect.

**In a recent** communication to the Paris Academie des Sciences, Mr. A. Witte referred to the popular belief that aluminum was in general unacted on by acids as erroneous. The apparent inalterability of this metal is really due to the fact that in the presence of such reagents the metal clothes itself with a layer of alumina, thin, but continuous and impervious. When, however, steps are taken to remove this coating or to prevent its formation, aluminum is very readily dissolved by acids, as was to be expected from its great heat of oxidation. A solution of common salt and acetic acid acts on the metal pretty rapidly, the reaction being greatest near the surface, where atmospheric oxygen gets most ready access to the metal. The solution in question has the power of dissolving alumina, thus robbing the metal of its protecting coat and exposing its surface to fresh oxidation, which is dissolved in turn. A solution of sea salt alone will act on the metal if oxygen and carbonic acid are supplied at the same time. Further, if a plate of aluminum, after immersion in sea water, is exposed to the air without being cleaned, the corrosion will continue for an indefinite period.

## MISCELLANEOUS NOTES.

**On Mr. J. W. Overstreet's** place, near Tifton, Ga., is an oak 12 feet 4 inches in circumference 15 inches above the ground and 11 feet in circumference as high up as a man can reach. It has a spread of branches of about 75 feet. The oak was set out just twenty years ago.—Savannah (Ga.) News.

**An observer** mentions the instance of a raven having lived sixty-nine years; a pair of eagle owls, one of which is sixty-eight and the other fifty-three years old; a Bateleur eagle and a condor in the zoological gardens at Amsterdam, aged fifty-five and fifty-two; an imperial eagle of the age of fifty-six, a golden eagle of forty-six, and a sea eagle of forty-two, and many birds of the age of forty downward are also recorded.

**The use** of barbed wire is increasing largely in Southern Italy. It is used for training vines, and is found of great service in keeping thieves out of the vineyards after dark. The vines being in many cases only a few feet apart, it is a matter of considerable difficulty to avoid the barbs even in the daytime, and at night it is practically impossible. The wire need be only of the lightest kind, as the lengths used are comparatively short and no cattle have to be contended with.

**It is** the common, though not the invariable, habit, in architectural books and other publications, to spell the word siphon with a "y," says The Builder. It is wrong, however, and falsifies the origin of the word, which is simply the Greek σίφων, signifying a hollow reed or tube. y in Latin and English is the correlative of the Greek u (υ); the letter i in Greek remains unaltered in Latin and English, except for the dot over it. Siphon is, therefore, the correct spelling, and ought to take the place of the unauthorized "syphon."

**Imports of** coal into Spain in January are reported by the Revista Minera at 103,424 metric tons; of coke at 11,319 tons. Imports of iron and steel included 367 tons pig iron, 237 tons wrought iron, 944 tons rails, and 33 tons tin plates. Exports of minerals for the month were, in metric tons:

| | 1898. | 1899. |
|---|---|---|
| Iron ore | 598,094 | 595,495 |
| Copper ore | 58,668 | 63,730 |
| Zinc ore | 2,330 | 3,584 |
| Lead ore | 554 | 995 |
| Salt | 14,715 | 16,616 |

Exports of metals for the month were 2,195 tons pig iron, 2,648 tons copper, and 12,768 tons lead.

**Tobogganing is** carried on on the Manitou and Pike's Peak Railway by the officials of the road. The vehicle employed is placed on the rack rail, and consists essentially of a plank 3 feet long by 12 inches wide. Along the middle of the underside a cleat fits between the rack bars and so keeps the toboggan from shifting sideways. On either side of the rack bars are brake shoes which can be brought into clamping action against the sides of the rack. The brake is operated by a lever which the rider holds within his grasp. To prevent undue wear of the plank where it bears on the top of the rack, there are strips of steel secured to the lower side, and to keep the slide from capsizing, a bar of iron extends on both sides to rest on the top of the ordinary rails, bearing and sliding on the smooth surface all the way. The front end of the plank has a rest for the rider's feet. The rider has simply to sit upon the toboggan and hold the brake lever in his hands to regulate the speed of descent. This may be as rapid or as slow as the rider pleases.

**Dr. Niessen**, British Vice-Consul at Cologne, has investigated the "brown" coal industry of the Rhine, and his report has been transmitted to the British Foreign Office, by Mr. T. R. Mulvany, British Consul at Dusseldorf, who believes the industry to be capable of great improvement. Mr. Mulvany adds: The low prices do not, if the fuel is extracted by manual labor, leave much margin for profit, but at such prices, with means of transport by rail to the Rhine, I see no reason why the briquettes could not be exported in light draught sailing craft direct to British seaports. It would then, however, appear advisable that British capital should be invested in the extraction and transport of this cheap fuel. Something might be learned from German industry in dealing with this fuel, inferior though it is when compared to the much older formations of the so-called mineral coal, by studying the best means of making money out of the vast peat turf bogs in Ireland by pressing that spongy, soft material into briquettes for transport throughout the country. There are doubtless greater difficulties to be contended with in pressing peat than lignite, owing to the former not being so glutinous or adhesive as the latter, but, in view of the great advances made in the applied science of chemistry and engineering, the thing, if not already done, can be done with commercial success.

**The changes** that electricity has wrought in metallurgical processes have acted to render less expensive many of the rarer metals, but there are now twenty-six elements more expensive than gold with which electric or other processes can be tried with much profit. The comparative rarity of these metals may be seen by quoting their European selling prices and comparing them with the market value of gold, which is given at 3,444 francs per kilogramme. A list of such metals and their value in francs per kilogramme would be as follows:

| | | | |
|---|---|---|---|
| Gallium | 787,500 | Strontium | 48,200 |
| Vanadium | 123,750 | Erbium | 42,100 |
| Rubidium | 112,500 | Ruthenium | 30,900 |
| Thorium | 95,600 | Niobium | 28,100 |
| Glucinum | 66,000 | Rhodium | 28,100 |
| Lithium | 56,250 | Barium | 22,500 |
| Lanthanium | 56,250 | Titanium | 12,650 |
| Calcium | 56,250 | Zircon | 11,940 |
| Indium | 50,650 | Uranium | 11,250 |
| Tantalium | 50,650 | Palladium | 6,430 |
| Yttrium | 50,650 | Tellurium | 5,625 |
| Didymium | 50,650 | Chromium | 5,625 |

From the foregoing it will be seen that gallium, the rarest, is 230 times as expensive as gold, while calcium, so commonly found in combination with other substances, is 18 times as costly.

## SELECTED FORMULÆ.

**Etching on Steel.**—Nitric or hydrochloric acids or mixtures of the two are employed as the "acid" in marking or etching on steel. The following are among the methods employed:

1. Glacial acetic acid..... 4 parts.
   Absolute alcohol..... 1 "
   Nitric acid (sp. gr. 1·28)..... 1 "

Allow the acetic acid and alcohol to remain for half an hour, then add nitric acid carefully. Etch from one to fifteen minutes. Of course the parts you wish to protect from corrosion must be covered with beeswax, tallow, or similar substance.

2. Cover the surface with a thin coat of asphaltum varnish of fine quality, then cut the design through to the surface of the steel and etch with a weak solution of nitric acid in water; finally wash with hot water and remove the asphaltum with hot turpentine.

3. Clean the steel and cover evenly with wax, cut the lines with a steel point through the wax and pour on the following etching fluid: Pyroligneous acid, 4 ounces; alcohol, 1 ounce; nitric acid, 1 ounce, by measure. Or use iodine, 1 ounce; iron filings, ½ drachm; water, 4 ounces. Etching fluid is removed as soon as the metal is sufficiently etched.

Etching on Cutlery, etc.—1. For etching on cutlery a ground wax is required, composed of equal parts of asphaltum, Burgundy pitch, and beeswax, melted together and thoroughly incorporated. In applying it use a dabber, or ball of cotton covered with silk. Warm the piece of cutlery so that a stick of the wax will readily melt by touching. Smear a small quantity of the wax on the blade or articles, and dab it evenly all over the surface. When cold, scratch the required design or name on the surface and touch the parts with acid (nitric acid 1 part, water 4 to 6 parts), using a camel's hair pencil to cover the surface and bring the acid into contact with all the lines. In a few minutes the biting is done. Dip in hot water to wash off the acid, and the surface may be cleaned by wiping with benzine. Another way is to make a varnish of asphalt and turpentine, with a few drops of linseed oil to make it tacky. Have a rubber stamp made of the required design, with a border, so as to stop off around the design. Stamp the goods, and with some of the varnish thinned down with turpentine and a brush stop off the surrounding parts; or surround the design with a small rim of beeswax, and apply the acid as above.

2. For etching brands and marks on polished steel surfaces, such as saws, knife blades, and tools, where there are many pieces to be done alike, procure a rubber stamp with the required design made so that the letters and figures that are to be bitten by the acid shall be depressed in the stamp. Have a plain border around the design, large enough to allow a little border of common putty to be laid around the edge of the stamped design to receive the acid. For ink, use resin, lard oil, turpentine, and lampblack. To ¼ pound of resin put 1 teaspoonful lard oil; melt, and stir in a tablespoonful of lampblack; thoroughly mix, and add enough turpentine to make it of the consistency of printer's ink when cold. Use this on the stamp in the same manner as when stamping with ink. When the plate is stamped, place a little border of common putty around and on the edge of the stamped ground. Then pour within the border enough acid mixed to cover the figure, and let it stand a few moments according to the depth required, then pour the acid off. Rinse the surface with clean water; take off the putty border, and clean off the ink with turpentine. Use care not to spill the acid over the polished part of the article. For the acid use 1 part nitric acid, 1 part hydrochloric acid, to 10 parts water by measure. If the effervescence seems too active, add more water. —Pharmaceutical Era.

**Impregnating Cotton Sailcloth.**—Sailcloth, allowed to lie about in wet condition or rolled up wet, will begin to rot, and we know that the spots cannot afterward altogether be removed by washing, and not even by chlorine. If dried in the stretched condition, the cloth will not spoil. This can be done on a fully manned boat, but not always on other crafts. Soap and brush, applied at once, will do some good. There is also a mistaken idea that rinsing with fresh water and drying in the sun will prevent mischief. To avoid all trouble the sailcloth should be impregnated. How this is done is described by Edward Gruene in Lehne's Färber Zeitung. The weaver's glue has first to be removed, which is accomplished by boiling a roll of about six pieces in malt, or also in caustic soda. In the latter case, every packet must have a fresh lye, but the subsequent washing in dilute hydrochloric acid does not call for a renewal of the bath every time. The cloth is dried hanging, as in all subsequent operations; there is more shrinkage on a cylinder. For impregnation a solution of alum and phenylate of lime is recommended. The impregnated cloth passes between two rolls, the upper of metal, the lower of paper. Finally comes the fixing with soda silicate. Gruene has found the treatment to answer well, and the cloth remains soft. If, after two years or so, a repetition of the impregnation should appear advisable, the cloth may simply be dipped in phenylate of aluminum.—Trade Journals Review.

**A Precaution in Stripping the Film from a Broken Negative.**—M. G. Roy, in the Bulletin de la Société Française de Photographie, points out that in using formalin or other chemical baths for the stripping of the film from broken negatives (negatives of which the glass only is broken, the film remaining entire), the liquid penetrating to the back of the film, through the rift in the glass, often brings about disagreeable and occasionally disastrous complications, which may be avoided by the following procedure: The negative is carefully laid, film downward, on a pad of clean blotting paper, and the rifts are well mopped over with thin India rubber solution in benzole. Strips of thin, transparent paper are now laid over the rifts, and when dry the whole back is brushed over with celluloid varnish.

**Lactic Acid Dentifrice Powder.**—

| | | |
|---|---|---|
| Lactic acid | 3·0 | grammes. |
| Powdered talcum | 30·0 | " |
| Oil of peppermint | 3 | drops. |

For removing tartar from the teeth.

## THE "BLACK DEATH" IN BUCHARA.

A FEW months ago the "Black Death" broke out in Auzob, a small village in the vicinity of Samarkand; and it seemed hardly credible when, a short time afterward, the newspapers reported that in Vienna a few cases of the same disease had appeared. To be sure, the conditions under which the plague established itself in two places so remote from each other were entirely different. In Vienna it was easy enough to prevent a spreading of the terrible disease; but it was far more difficult to ascertain how the deadly germs could be brought from the distant mountain village in Central Asia to the Austrian metropolis. Thanks to the extraordinary energy of the Russian government, it has been possible to confine the plague to the forsaken corner of the earth where it broke out, and even there to check its ravages. Prince Alexander Petrovitch, of Oldenburg, a man of rare energy and judgment, who, although a soldier by profession, has interested himself to such an extent in bacteriology that, at his own expense, he has founded a bacteriological institute at St. Petersburg, was appointed by the Czar head of the Plague Commission on the breaking out of the plague in Bombay, and was ordered to take command of an expedition of physicians, nurses, and soldiers which was to proceed to Samarkand in order to study the conditions on the spot and to take the proper steps to prevent a spreading of the disease. The fate of Europe from a sanitary point of view for a time depended upon this man, whose task it was to check the ravages of the "Black Death."

In view of the great interest which this matter has aroused in the civilized world, a few pictures from the district in which the Russian plague commission has been working may not be unwelcome.

Buchara, owing to the mode of life of the people, to the trade with the exterior, and to its bad sanitary condition, must be sternly watched. From the local government no assistance is to be expected; for although the Emir, Said Abdul Achad Chan, according to Asiatic notions is an enlightened man, the plague can be stamped out only by the strictest Russian military discipline. Should the plague become more malignant, the Transcaspian railroad would be a means of communicating the disease to the West; quarantine stations could, however, be established along the road to prevent such contagion. It would be more difficult to watch the many caravans which traverse all parts of Central Asia, and which are particularly numerous on the trade lines between Buchara and India. The camel-drivers, owing to their uncleanliness, constitute a dangerous medium for the communication of the disease. The bazars are also dangerous; for here people from all parts of Asia are thrown together in motley crowds. Great care must also be exercised at all other gatherings, particularly at those where the boys termed "Batchis" dance for the amusement of the onlooker.

SAID ABDUL ACHAD CHAN, EMIR OF BUCHARA.

In Buchara but few crimes are committed; nevertheless, the jails are always full; and at all times there are among the prisoners some who have been condemned to death. It is not so very long since the death sentence was carried out by casting the condemned into a pit swarming with vermin, in which, after a few hours, the offender was reduced to a skeleton. Instead of being thus cruelly put to death, the condemned was sometimes thrown from a high tower. Nowadays, it is considered sufficient punishment merely to chop off the hands of thieves and to cut the throats of more serious offenders.

Between the infected district of Samarkand and the Caspian Sea there lies a vast desert of sand, broken only here and there by an oasis, and therefore but sparsely populated. Through this region the plague could be communicated only along the tracks of the Transcaspian railway, the caravan trade since the opening of the road having diminished almost to nothing. The population, scattered as it is in villages remote from one another, can be readily watched. Moreover, the Turkoman races have reached a higher stage of civilization than the other tribes of Central Asia. It is astonishing how this wild, robber people, before whom all Middle Asia once trembled, have, ever since their subjection, become peaceful and even loving subjects of the Czar.

The fierce robber of old now tills the soil or serves the Czar as a soldier.

From the foregoing brief account it can be inferred that a spreading of the plague westward is not to be feared. To the skill and energy of the Prince of Oldenburg must be left the task of crushing the disease.—Ueber Land und Meer.

A TURKOMAN CAMEL-DRIVER.

A DANCING BOY (BATCHIS), A BAZAR IN BUCHARA.

SCENES FROM BUCHARA.

## UNIVERSITY OF PENNSYLVANIA LECTURE COURSE. I.

### LIFE AMONG THE CRUSADERS.*

DURING the period of the crusades, western Europe made a remarkable advance. When Urban II. preached the crusade of Clermont, he set in motion a force destined to revolutionize Christian society. In his speech he depicted the necessity of aiding Constanti-

* A lecture delivered March 6, 1899, by Dana C. Munro, A.M., Professor of Mediæval History, of the University of Pennsylvania, at the University College Hall. Revised for the SCIENTIFIC AMERICAN SUPPLEMENT by the author. All rights reserved.

nople, the bulwark of Europe, against the Turks. He commanded the members of his audience to turn aside from the petty strifes in which they were engaged and to join in a common undertaking to free Jerusalem and the Holy Land from the infidels. This end was not accomplished, but the attempt, which went on vigorously for more than a century, caused a great change in the West. The crusaders, by their contact with more advanced civilizations, learned much; economical conditions were improved; commerce became more active; the mental horizon was broadened.

In order to understand how this took place, we must follow the crusaders to the Holy Land, see what their life was, and under what influence they came. The first crusaders—the Franks, as they were commonly called—succeeded in capturing Edessa, Jerusalem, and Antioch; but not in conquering the country itself, only a small portion of which fell into their hands. After the main army had gone home, the few thousands that remained were barely able to garrison the more important strongholds. They could not even protect the road from Jerusalem to Joppa.

Saewulf, who made a pilgrimage in 1102, describes the dangers thus: "We went up from Joppa to the city of Jerusalem, a journey of two days by a mountainous road, very rough and dangerous on account of the Saracens. They lie in wait in the mountain caves to surprise the Christians; they watch both day and night in order to fall upon small companies, or the weary who may chance to lag behind their companions. At one moment we see them on every side, at another they are altogether invisible. Numbers of human bodies lie scattered in the way and by the roadside, torn to pieces by the wild beasts. Some may, perhaps, wonder that the bodies of Christians are allowed to remain unburied; but it is not surprising when we consider that there is not much earth on the hard rock to dig a grave; and if earth were not wanting, who would be so simple as to leave his company and go alone to dig a grave for his companion? Indeed, if he did so, he would rather be digging a grave for himself than the dead man; for on that road, not only the poor and weak, but the rich and strong, are surrounded by perils. Many are cut off by the Saracens, but more by heat and thirst; many perish for want of drink, but more by too much drink. We, however, reached the end of our journey in safety. Blessed be the Lord!"

For the next forty years the Franks added slowly to their possessions; each year new crusaders came under a vow to remain a year or two and fight for the cross. Each autumn saw new possessions in the hands of the Christians. By 1140 they had succeeded in securing most of the important cities on the coast and in the valley of the Jordan, with a few fortresses on the mountains between. In the northeast they held Armenia. But the enemy was constantly at hand. Few places, if any, were more than two days' march from some stronghold of the Mohammedans; often the enemy were at a distance of only a few miles. The character of the country rendered it difficult to dislodge them, or to maintain easy communication between the Frankish fortresses. Syria is more than five hundred miles in length, but only about fifty miles in breadth, except in the extreme north. It is composed of four longitudinal zones; first a coast plain

A TURKOMAN FAMILY AND HUT.

TURKOMAN FARMERS.

SHACKLED CRIMINALS IN BUCHARA.

SCENES FROM BUCHARA.

along the Mediterranean, in places four or five miles wide, in other places the mountains come down to the sea and there is no level ground. Back of this a range of mountains, rugged and, for the most part, barren. To the east, again, the valley of the Jordan; and back of this a high range of mountains, with the deserts beyond. On both of the ranges of mountains the Saracens maintained strongholds. Many of the important cities in the interior, as Damascus and Aleppo, were always in their hands. Along the seacoast, travel was often difficult, where the mountains came down to the sea and the steep roads were exposed to constant attacks.

The Templars made it a pious duty to convoy travelers from one place of pilgrimage to another. The coast cities were generally built on peninsulas or promontories jutting into the water, as in the case of Sidon. The Franks never formed the majority of the population in the Holy Land; in fact, they were greatly outnumbered by the other inhabitants. They owed their position very largely to the fact that the enemy were disunited and were fighting among themselves quite as frequently as they were engaged in the Jihad, or Holy War, against the Christians. Until Noureddin came into power, about 1140, the Mohammedans had no leader. When he died, in a few years they again broke up into petty cliques, and came together again only forty years later under Saladin. The inhabitants of the Holy Land (aside from the Franks) were composed of men from many nations. The Turks, Arabs, Syrians, Armenians, Greeks, and Jews were the most important. The country was far more thickly populated than at the present day, after centuries of Turkish misrule. Its geographical position, in the middle ages, was far more advantageous than now. Then the chief commerce of the world centered in the Mediterranean basin. Now the Mediterranean commerce plays only a small part. During the middle ages Syria was the natural place of communication between the East and the West. Except when political troubles barred the way, the majority of the wares which were exchanged between the East and the West passed through her ports.

Antioch is an example of the decay of population into which most of the cities of the Holy Land have fallen. Comparing the extent of the present town with what it was in the crusading times, we find the population living in the southeast corner of the old city. Most of the enormous extent of the old city is now either farms or else barren ground. The whole country was better cultivated and the civilization far higher than at the present day. The Arabs led in almost everything, except fighting ability. They had many schools, universities, and libraries. Ousama, a Saracen emir of the twelfth century (to whose autobiography we are indebted for much of our information), had a private library of over four thousand volumes. Other libraries of equal size were not at all uncommon. In this connection, it is well to realize that in the West, at this date, a library of two hundred volumes was highly prized; and very few of the richest monasteries had a library that would number five hundred volumes.

The Jews were but little behind the Arabs; the Greeks almost their equals in the Holy Land itself, far in advance at Constantinople. The Seljukian Turks, although barbarians in many respects, were patrons of learning. The foundation of a college was for them a pious act, like the sacking of a Christian city. The numerous Turkish princes vied with each other in encouraging education, so that Cairo and Bagdad became centers of learning. Scholars were sought in all parts of the world and liberally paid to remain at the courts of the Seljuks. This atmosphere of education was something unknown to the Franks at the time. It reminds us strongly of the University of Paris in the following century. We shall have occasion, later, to refer to the many arts and trades common in the Holy Land and comparatively unknown in western Europe. The contrast for the Franks, with the narrower life of their old homes, was striking. However bigoted they were, they learned rapidly from their neighbors; and they came constantly into contact with the latter, at first chiefly in warfare. The crusaders entered the country with a great contempt for their opponents; but they soon learned better, and began to praise their skill in battle. They said if the Turks were only Christians, no nation in the world would excel them in warfare. A legend grew up that the Turks and Franks were descended from the same ancestors, because they two excelled all other nations in valor. Cities like Antioch struck wonder and consternation into the minds of the crusaders.

To capture these cities they were compelled to perfect their siege engines. The mangonel and ballista were their two most important siege engines. The former was used for battering down walls as well as for killing the enemy. Sometimes they did remarkable execution. One stone thrown by a mangonel at the city of Acre, which killed twelve men, was long preserved as a curiosity by the Saracens. Richard the Lion-hearted, and especially Philippe Augustus, were specially noted for their inventiveness in constructing these engines. The latter constructed one with great skill at Acre, only to have it broken by a stone thrown from an Arabic machine, and then rebuilt it and finally succeeded in battering down the wall of a part of Acre. From their opponents they also borrowed a most effective weapon, the crossbow. This was so destructive that its use among the Christians was condemned. A church council, early in the twelfth century, forbade it to be used against Christians and pronounced it a really devilish weapon.

To hold the land, they were compelled to build castles far larger and stronger than those to which they had been accustomed in the West. The most noted example is Crac. This was in the country of Tripoli and commanded two important roads from the interior to the coast. It was taken by the Franks in 1125 and given to the Knights of the Hospital in 1145. The original castle suffered repeatedly from earthquakes during the twelfth century. After 1202 it was rebuilt by the Franks in practically the shape in which we see it now.

Owing to their close proximity, they were constantly engaged in petty strifes with the Mohammedans. An affray might arise any day when the two happened to meet. Single combats taught them to respect each other. In one such combat which took place in the early years of the twelfth century, we learn that a single Saracen succeeded in putting to flight two Frankish knights and pursued them until he came to a narrow defile. There, fearing an ambush, he turned back. The two knights were promptly degraded by Bohemond, who had seen the whole affray from his watch tower. Their armor was stripped from them and thrown into a barnyard. The knights felt it to be a great humiliation; but the Saracen was equally disgraced for not continuing the pursuit. Truces were frequently made and the two peoples came into friendly intercourse. Very early in the twelfth century we find Christians allying themselves with the Mohammedans against other crusaders. Baldwin I. subdued his vassals, when rebellious, with troops furnished by the Turkish allies. As time went on, such political alliances were increasingly frequent. When Frederick I. started out on the third crusade, he made an alliance with the Sultan of Iconium. When he got to Constantinople, he found that his enemy, the Emperor of Constantinople, had made a similar alliance with Saladin; and, consequently, we find in this crusade one Christian and one Mohammedan power arrayed against a second Christian and second Mohammedan power. This was the chief cause of the difficulty of Frederick Barbarossa's crusade. When they came into these friendly relations, the Franks learned rapidly from their chivalrous enemies. Owing to the good faith which the Mohammedans kept, a proverb grew up, and it was the highest compliment to a Frankish knight to say that he was "as true as a Mohammedan." Their manners became softened as the crusaders saw the courtesy of their opponents and did not wish to be outdone. As an example of such courtesy I shall cite the description of Saladin's actions after the conquest of Jerusalem in 1187. This was written by a Christian who was present: "Then I shall tell you," says the Squire of Baliou, "of the great courtesy which Saladin showed to the wives and daughters of the knights who had fled to Jerusalem when their lords were killed or made prisoners in battle. When these ladies were ransomed and had come forth from Jerusalem, they assembled and went before Saladin, crying mercy. When Saladin saw them, he asked who they were and what they sought; and it was told him that they were the dames and damsels of knights taken or killed in battle. Then he asked what they wished, and they answered, 'for God's sake, have pity on them; for the husbands of some were in prison, and of others were dead, and they had lost their lands, and in the name of God, let him counsel and help them.' When Saladin saw them weeping, he had great compassion for them and wept himself for pity. And he bade the ladies whose husbands were alive to tell him where they were captives, and as soon as he could go to the prisons he would set them free. (And all were released, wherever they were found). After that, he commanded that to the dames and damsels whose lords were dead there should be handsomely distributed from his own treasury, to some more, to others less, according to their estate; and he gave them so much that they gave praise to God and published abroad the kindness and honor which Saladin had shown to them."

If we contrast with this the capture of the same city in 1099 by the Christians, we see the immeasurable superiority of the Moslems. In 1099 Godfrey and the other leaders wrote home exultingly to the Pope, "If you desire to know what was done with the enemy found there, know that in Solomon's porch and in his temple our men rode in the blood of the Saracens up to the knees of their horses." Neither age nor sex was regarded.

But the Franks in the Holy Land had learned. In the last years before the capture of Jerusalem we find a very different spirit among the Christians who had grown up in the Holy Land. When Saladin directed the fifth siege of Kerak in 1184, a wedding was being celebrated in the castle. The garrison was surprised, and the castle would have been taken but for the valor of a single knight. Like Horatius in the olden days of Rome, this knight held the bridge against the Saracens until the garrison had sawed it through at the other end. As soon as the castle was in safety, Reginald, who was in command, "sent Saladin meat and wine"—as it were a piece of the bride cake—to share in the feast; and in return Saladin gave strict orders to proclaim to the army that the nuptial tower of the bride and the bridegroom should be scrupulously respected by his archers and artillery. The second half of the twelfth century is marked by many such acts of courtesy. Two horses were sent by Saladin's brother to Richard the Lion-hearted when the latter was unhorsed in battle. Richard accepted the gift with thanks, and used the horses to the discomfiture of the enemy. The Christians treated their Moslem subjects so well that their rule was preferred by the latter. Ibn Djobeir told with grief, in 1184, that he "found his fellow Moslems preferring to live under Christian rule, because it was lighter and juster than that of the Turks."

The barbarous actions in the last years of the twelfth century were usually due to the newcomers, who had not yet fallen under the influence of the country.

Naturally the invaders soon intermarried with the natives. Baldwin, of Edessa, married an Armenian princess before the end of the eleventh century, even while the first crusade was in progress. Those who remained after the first crusade frequently contracted alliances with the women about them. This movement was hastened by the general dissoluteness in morals. From these native women they learned new tastes, costumes, and habits. Prince Tancred, at Antioch, caused coins to be struck representing himself in oriental dress and wearing a turban. This was early in the twelfth century. The movement spread, as it was inevitable that the cumbersome clothes suited to the severity of western climates should be discarded for the lighter and more elegant costume of the East.

For the native costumes, we are fortunate in having an account of a wedding celebration at Tyre, written by Ibn Djobeir. "All the Christian men and women assisting at the fete were drawn up in two lines before the bride's door. Trumpets, flutes, and all kinds of musical instruments resounded. They awaited thus the bride's departure. She appeared at length, conducted by two men who supported her on either side, who appeared to be her kinsmen. She was splendidly attired according to their usual mode of dressing, and wore a magnificent silk robe embroidered with golden thread, whose long train swept the ground. Upon her forehead rested a diadem of gold, covered with a fillet of cloth of gold, and her bosom was adorned in the same manner. Thus clad, she advanced trippingly, with measured steps, like a turtle dove, or the dust moved by a gentle breeze. (May God preserve us from the temptations which such spectacles excite.) She was preceded by Christian magnates and followed by Christian women, who advanced mincingly with their most beautiful ornaments trailing behind them. The procession started, the orchestra at the head; while the simple spectators, Mussulmans and Christians, ranged themselves in two rows to assist in the march. The cortege proceeded to the house of the bridegroom, which the bride entered, and the whole company spent the day in feasting. Such was the magnificent spectacle at which chance permitted me to be present."

The style of architecture changed insensibly as the Franks became accustomed to the luxuries about them. After the capture of Jerusalem, in 1099, a contest had arisen among the leaders for the possession of the tower of David. I suppose because it reminded them of home. Later, a different style of dwelling, more suited to the climate, was in demand. The Arabs of the better class loved to have fountains in their homes. In the cities, public bathing establishments were common. By the example of the Saracens the Franks contracted the habit of bathing frequently. "Cleanliness is next to godliness" had not been the prevailing notion in the West. In their foods they came in contact with many new products. In particular, they learned the use of spices.

There were unfortunate consequences, also. A people of a lower civilization, coming into contact with a higher civilization, always adopts the vices of the latter first. We can see this in all history and in our own day. I shall not dwell upon the darker side of this picture. The Frankish inhabitants were composed of men from all the nations of the West. Many were adventurers; many had been compelled to leave their own country because of their crimes; and all were removed from the restraining influences of their home surroundings. We can realize that the degradation was in many cases frightful. The offspring of these mixed unions formed, by the middle of the twelfth century, a very appreciable element in the population. They were called Pullain, or Creoles. They were generally inferior to their parents in vigor and morality and were despised by the Franks. Sometimes they became Mohammedans; more frequently they remained nominally Christians, but in reality had little faith in any religion. They had learned one from their father, another from their mother; they generally held the superstitions of both, and little more.

There is material for many a romance in the lives of individuals under these curious circumstances. Some young Frankish girls were captured by a Saracen. The most beautiful was richly adorned and sent as a present to an Arab prince. He was delighted with her, reserved her for his own harem, and she became his favorite wife. Her son became his heir and succeeded the father. The mother was highly honored and ruled over the city; but she pined for her people and determined to escape. She let herself down from the city walls by a rope and succeeded in reaching the nearest Frankish town and there she married a Frankish shoemaker, while her son continued to rule his principality. Such examples are not at all isolated instances in the history of the Holy Land.

The crusaders were supported to a considerable extent by contributions from the West; but they had to derive their main income from the cultivation of the land. They did not carry on the cultivation of the soil themselves, but often under a style very similar to that of the lord of the manor. The native population cultivated the fields and paid to the Frankish overlord one-half of the crops, besides furnishing work at certain periods and making small money contributions. This was not regarded as burdensome by the people; in fact, they preferred to live under the Franks rather than to serve their native lords. Frequently a Mohammedan overseer looked after the interests of the Christian master. This farming, again, brought the crusaders into close contact with the native population and also enabled them to learn some new methods of agriculture; for the agriculture was much more highly developed than in the West. They also learned to construct windmills, which, later, were introduced into France, England, and Germany. Sugar-cane, cotton, and watermelons are among the agricultural products brought into common use by the crusaders. Another great source of wealth was commerce. After the first two crusades the Franks usually went to the Holy Land by sea. Large vessels were fitted to convey them, their horses and supplies. The vessels, on their return, furnished a ready means of carrying commodities to the West. The cost of transportation was almost eliminated, as many of the vessels would have been compelled to return in ballast if they had not secured these commodities. As the latter were frequently the spoils of battle, they became much cheaper in the Holy Land itself. Eastern luxuries consequently became cheaper in the West, and their use spread among largely increasing classes. Trade became more active. Money was circulated much more rapidly than before. I do not think there was any appreciable increase in the quantity of precious metals in the west of Europe before 1204; but money was actually circulating more rapidly, because the gold and silver which had, to a great extent, been hoarded (especially in works of art in the churches), had been drawn forth to equip the crusading armies. This money had, to a great extent, fallen into the hands of the trading classes in the cities, by whom it was kept in circulation. The result was a rapid progress in wealth and comfort, and a demand for luxuries, especially for those coming from the Orient.

An interesting result is an advance in the art of navigation. Before the crusades the art of tacking was unknown; but when the crusades began it was necessary to use larger vessels. They had to tack, they could not always wait for favorable winds, and they could not row these vessels.

Among the Franks the Italians carried on the trade, especially the Venetians, Pisans, and Genoese. These people reaped the greatest commercial advantages from the crusades. In the Holy Land, however, the greatest merchants were Arabs. In the last part of the twelfth century there was one great merchant prince in particular who had his agents throughout the East

and whose wealth was phenomenal. He was possibly the most influential man in Syria. Certain industries were at that time carried on almost exclusively in the Holy Land. The most important were dyeing and the manufacture of finer glasswork, which the Venetians, later, learned from the Orient, and still practice. Both these industries were almost entirely in the hands of the Jews. The dye employed was the famous Tyrian purple, made from small shell-fish, common in different parts of the Mediterranean. I have found many of them in the Bay of Naples; but the use of them for dyeing purposes seems to have been confined to the eastern coasts.

Four different styles of shell-fish were used for procuring this dye. The shell-fish with the shell was placed in a large vessel and boiled for a certain length of time, then the whole was taken out together and mashed, and the juices, dropping out gradually, after being exposed to the sun, made the Tyrian purple, but the different shades of it were made by exposing the garment which had been dyed, for a greater or less length of time, to the sunshine, or else by dipping it two or more times. That was the only difference in the shade; but the sun was sure to set the dye, and, as we know, Tyrian purple never faded. At this time it was still carried on as it had been carried on for three thousand years before.

Commercial relations again brought the crusaders into close contact with the native inhabitants. Even in times of war we find that the merchants of either religion visited the camps of their opponents in pursuit of commerce. After the middle of the twelfth century traveling was generally safe for all. Safe conducts were constantly granted by the Mohammedans or by the Christians at the request of the other. Benjamin Tudella, a Jew, has left us an interesting account of a journey he had made in the Holy Land in 1163 to 1164. He traveled with perfect ease, and visited almost every city of any size in the Holy Land, and even many of the smaller villages. In every place he was interested in discovering how many Jews were living there, and, to our great surprise, we find in the Holy Land he enumerated at this period over twenty thousand Jews; in some cities as many as three thousand, in others three to a dozen, in many cases none. Everywhere he went he inquired how many Jews there were, their state of education, their occupations. He has given us an excellent photograph of this class of society. We have a better knowledge of just what the Jews were doing at this period in the Holy Land than of any other people.

The amusements of a people are always an excellent indication of its character. A history of its games shows the evolution of a race and its advance or decline in morality and civilization. For want of time I shall mention only two or three characteristic amusements among the Franks. Next to fighting and hunting, hawking was most conspicuous. A whole chapter of the assizes of Jerusalem is devoted to this subject. Both Arabs and Turks engaged in it. The breeds of hawks were carefully cultivated, and the names of famous birds have been preserved. This amusement was not peculiar to the East or this period, it was common in Europe, and was practiced for centuries. One amusement showing the character of the civilization is thus described: "I was at Tiberias when the Franks were celebrating one of their festivals. The knights had departed from the city for a tournament. They carried with them two decrepit old women, whom they placed at one end of the hippodrome. At the other end, on a bit of rock, they tied a pig. The knights ordered the old women to race for the pig. Each one started, accompanied by a number of brave knights, who kept getting in their way to hinder them. At every step the old women would tumble, and then get up again, amid great bursts of laughter from the spectators. At length one of them reached the end and seized the pig as a prize for her victory." But more refined amusements were creeping in; chess playing was becoming a favorite diversion. The Arabs were noted for their skill in this pastime. Some of their players were able to carry on a game without seeing the board, and to perform other feats well known to chess players.

In the trial of cases, the Franks still used ordeals and the wager of battle. These customs had been adopted by the Christians from the old Germanic civilization. In the early days of Europe it was almost impossible to get witnesses, and recourse to divine justice had seemed the only thing possible. The ordeals took various forms, but in every case God was expected to maintain the right. In the case of the wager of battle, two champions were selected; the one who conquered was supposed to have maintained the justice of his cause. These methods seem to us very primitive, as they did to the Arabs; but in an age of faith they were far more effective than they would be now, and in many cases it would have been impossible to secure any proof. In fact, we know how many crimes go undetected and unpunished at the present day, even in our more advanced civilization, and it was little wonder that this wager of battle held its place in the Frankish civilization for centuries.

From all these details it is evident that the Franks were very closely in contact with the people among whom they were living, and that their intercourse, after 1150, was generally friendly. The best proof of this feeling is that many of the young Frankish natives were sent to Arab princes to be educated. This also shows clearly how highly the Franks prized the Arabic civilization. It is not at all strange that we find many of the Franks adopting the ideas and superstitions of the Arabs, and some of them even becoming Mohammedans.

Among the Franks who lived in the Holy Land, a civilization was growing up vastly superior to any they had known previously. They loved the country and enjoyed their life in it. Their policy was to remain on good terms with the infidels. The Templars and Knights of the Hospital (orders which had been formed mainly for the purpose of fighting the infidels) came into close and friendly relations with the latter. They had acquired great wealth and had absorbed the higher civilization. They were still valiant soldiers in case of need; but they generally preferred to live in peace with the people, whom they admired and respected.

This was prevented by the newcomers. Men came each year, fresh from the ruder civilization of the West, into the Levant, and anxious to fight. Some looked on peace with the infidels as sacrilegious; others were adventurers, desirous of war and booty. Holding it unnecessary to keep faith with infidels, they violated treaties and brought disasters on the Christians. The result was the loss of Jerusalem.

We get a vivid picture of the contrast between the Templars and the newcomers from an anecdote related by Ousâma. "When I was at Jerusalem, the Templars, my friends, assigned to me a little mosque outside of their church, in which I could perform my devotions. One day I entered it to give praise to Allah. I was deep in prayer when one of the Franks seized me and turned my face to the east and said, 'That is the way to pray.' I again proceeded to pray. Escaping from his guardians, the same man threw himself upon me again and turned my face to the east, repeating, 'That's the way to pray!' The Templars again expelled him and made excuse to me, saying: 'He is a stranger; he has just come from the land of the Franks; he has never seen anyone praying who did not turn to the east.' I replied, 'I have prayed enough for to-day,' and departed."

These transient visitors aided in carrying the higher civilization to the West. After remaining a year or two in the Holy Land they took back home with them the new ideas and new tastes learned. We can trace this influence by the increase in the use of spices in the West. Before the crusades these were rare and costly; in fact, if we take up their history somewhat more at length, it is extremely interesting to see how they had been in common use during the Roman times and then had dropped out from general use for a considerable period of time. When Alaric was about to sack the city of Rome in 410, he demanded as a ransom for the city three thousand pounds of pepper, among other things; and this did not seem extravagant to the people at the day. Some three hundred years later, when the Venerable Bede was on his death bed, he said that he had a few objects of great value which he had saved up and wished to bestow upon his friends. Among these was a small quantity of pepper. Of course, the use of pepper had gone out almost entirely in that interval. It came in very rapidly after the first crusade and continued to be used. Matthew of Paris relates, in the thirteenth century, that the Mohammedans had formed a plot to murder all the Christians by poisoning the spices which they sent to Europe; and a little later, it appears that the "masses are using all kinds of spices commonly, and that they have passed into general use throughout the West." Indeed, one of our medical authorities has stated that "Spices were

DR. DIFFRE'S CRADLE INCUBATOR FOR NEWBORN INFANTS.

used in larger quantities in the average homes of the better class in the thirteenth century than at the present day." In addition to their use in making food more palatable, they were employed largely in medicine and for preserving food. Before ice came into general use and before spices were used for this purpose, the only way of preserving food for winter was by salting and smoking; and when spices were added, it made a large addition to the bill of fare during the larger part of the year.

Although it is a little digression, I will describe the development in the armor. The armor worn changes rapidly during the period of the first crusade and the half century following. It passed from the loose fitting mail coat of steel rings, through the grand hauberk to the mail plate of the fourteenth century. The armor seems to have been made of either linked chains or of plates sewn upon a leather background, or welded closely together. If made of plates, the garment was generally long and often sleeveless; if of chains, it fitted closely the body and generally covered the arms, while short, armored breeches protected the thighs; but when the crusaders came into contact with the Turks, armed with the cross-bow, this defense was found insufficient. It was ample for their kind of arrows but no protection whatever for the cross-bow. Soon after the first crusade a change set in, consisting of the introduction of the hauberk, which, in its final form, as the grand hauberk, was composed of two parts, forming a closely fitting chain tunic that covered the whole body to the knees, with an undergarment protecting the legs and reaching as far upward as the waist. The grand hauberk was simply formed of interlocking rings. It was cloven behind, so as to facilitate horsemanship. In most cases the hauberk seems to have been fitted with a ring-mailed hood. Just as the crusades were ending we may trace the faint beginnings of plate armor. Gradually the two simple garments gave way to a multitude of detachable pieces, each with its own particular use and special name; but this development does not fall within our period.

Most of this description of armor has been taken from Archer & Kingsford's work on the crusades, in the "Story of the Nations" series, which is by far the best single volume on the history of the crusades in the English language.

When thus clad in mail the knight was unrecognizable. As a rule, each one had to adopt some device by which his fellows could tell him in battle. The sprig of broom plant from which they took their name marked the Plantagenets. In the Holy Land this use was widely extended, and resulted in armorial bearings. Many of the terms in heraldry betray their Eastern origin, as they are merely Arabic words taken over into French.

Family names developed rapidly in the Holy Land for the same reason. When there were dozens of knights named Gilbert, or Godfrey, or Stephen, it was necessary that each one should be known by some distinctive epithet. In their own homes, where the knight was all-powerful, where he was living, for the most part, at his castle in the country, it had been entirely unnecessary for him to have any distinguishing name, Lord Hugh or Lord Gilbert represented something very distinct; but in the first crusading host there were not far from one hundred thousand fighting men; the whole host probably numbered nearly half a million. The chroniclers of the time tell us that six million took the cross, but the real truth is that there were not far from one hundred thousand fighting men; and among these hundred thousand fighting men, with the paucity of names prevailing in the middle ages, there must have been at least hundreds, on the average, of each name; hence, as a rule, each one had to have some distinctive epithet. These names were derived frequently from personal peculiarities or from the place in which the men had lived previously. Broadhead, Strong, White, Byfield, Atwater, will suggest such derivations. Other names came from the occupations in which the men had been engaged; Smith and Clark (clerk) are the most common examples. But this subject is sufficient in itself for a lecture.

I trust within this brief space of time I have succeeded in illustrating the great progress made by young Europe when it was at school in the Orient. From the lessons learned there it was enabled to advance rapidly, much more rapidly than ever before. All of the advance during the crusading period is not to be attributed to the influence of the Arab; very many of the results which actually did take place would undoubtedly have taken place even if the crusades had never occurred; but I think it is also undoubtedly true that they came much more quickly than they would have done but for the crusades. Thrown into contact with this people of a higher civilization than their own, and learning rapidly from them, the Franks made rapid strides in civilization. The thirteenth century in European history is a wonderful one, resembling in many points our own, the nineteenth century; and very much of this advance is to be attributed to the crusades; in fact, in many cases we find them actually bringing in new things they had learned in the Holy Land, actually adopting at home customs they had seen elsewhere. Hospitals, for instance, which had grown up in the Holy Land, due to the necessities of the pilgrims, became very common in western Europe in the thirteenth century. Previous to that time there had been some few establishments at special points for the needy, but hospitals were very common in the Holy Land itself, and the crusaders there seemed to have learned what excellent things they were. In very many lines of life we can trace this wonderful progress; especially after the capture of Constantinople in 1204, by the Franks, we can trace a great advance in the learning and wealth due directly to that capture; and it has been rightly said that "The roots of the Renaissance are to be found in the civilization of the crusades."

## A CRADLE INCUBATOR FOR NEWBORN INFANTS.

WE have already, at various times, treated of the question of the hygiene of newborn babes, and, apropos of this, have pointed out the benefit that may be derived from the use of a good incubator for the preservation of the lives of an incalculable number of infants which, otherwise, would be doomed to almost certain death.

We have now to make known a new form of incubator that was exhibited at the last Congress of Pædiatria, and which appears to us to offer great advantages.

The idea of the cradle applied to the incubator is indisputably a happy one, because it dispels every idea of an "apparatus" from the agitated mind of young mothers, does not wound their very legitimate self-respect, and makes them unhesitatingly accept a process of treatment that, unfortunately, has hitherto often been refused under the pretext that incubators are of funereal aspect and resemble coffins or the showcases of anatomical museums.

The new apparatus, which is wholly of metal, is light and of a handsome shape, and permits of thorough disinfection through the application of a flame and washing with antiseptics.

It consists of an ordinary cradle of tinned copper closed above by a movable plate of glass and heated beneath through a reservoir of water which a kerosene lamp keeps continually and very regularly at the temperature fixed by the physician. It is of extreme simplicity and may be employed by the most inexperienced person, who, in less than two minutes, will understand it well enough to take charge of it.

In it we remark three essential parts: The incubation chamber, the boiler, and the lamp. The chamber, which is all in one piece, contains a movable bed formed of wire gauze, a bowl containing a sponge for moistening the air, and a thermometer, all of which may be removed at will for the purpose of sterilization. Finally, there are two apertures diametrically opposite each other for permitting of constant aeration.

To the bottom of the cradle is soldered the boiler, which is of a new and special type. It is entirely closed, but is provided with a siphon tube which puts its interior in communication with the external air. This ingenious arrangement prevents a loss of water, so that the same liquid may be used for two months. In order to appreciate a boiler that dispenses with so much work, one should have witnessed in the old style of incubators the drudgery of filling the boilers every two hours, day and night, for several weeks and months.

Finally, the water in the boiler under consideration is heated by a lamp, of which it suffices to regulate the wick according to the readings of the thermometer in order to keep up the temperature that is desired. The

daily cost of running the apparatus is insignificant, and amounts to no more than three cents for twenty-four hours.

Such is Dr. Diffre's cradle incubator. Truly practical, it is worthy of being made known and popularized, because it furnishes an excellent means of combating that fearful mortality of the first months of life (even in children born at the full period, but sickly or puny) by attenuating that abrupt transition of from 20 to 25 degrees which affects the newborn and makes so many victims.

For the illustration and above description we are indebted to La Nature.

## WIRELESS TELEGRAPHY.

M. MARCONI, whose apparatus for telegraphing without wirss we have already described, has recently been conducting some experiments with it in which he succeeded in sending regular communications between France and England, over the English Channel.

At Wimereux, near Boulogne-sur-Mer, there stands upon the beach a mast made in sections and 177 feet in height. This mast exchanges signals with a similar one erected upon the English coast, at thirty miles distance. Near each mast there is situated a small building. A thin steel wire descends from the upper extremity of the mast and enters one of these structures through the window. Upon entering the Wimereux station, we find M. Marconi represented by two of his assistants, Messrs. Kemp and Bradfield. The arrangement placed before them resembles that devised by M. Ducretet. A Ruhmkorff coil is the apparent piece of the transmitting apparatus, while the receiver is the ordinary Morse apparatus.

At any time, no matter whether the sea be rough or smooth, the atmosphere clear or foggy, or the wind blowing a breeze or a hurricane, a communication may be established at will between England and France, the electric waves proceeding from one shore to the other from the mast that we have just mentioned to the opposite one, which is concealed by the curve of the sea.

While our collaborator was in the experimental room taking the photograph which is reproduced herewith, says L'Illustration, the "Cassini," with M. Lockroy, Secretary of the Navy, aboard, passed in view of the coast. Messrs. Kemp and Bradfield immediately transmitted the news from the other side of the strait. Not a minute had elapsed when the reply arrived: "If the secretary comes to see you, give him a good reception."

The phrase was inscribed upon the tape in dashes and dots as regular and clear to the telegrapher as if it had come over a gutta percha covered wire resting upon the bottom of the sea.

After witnessing an experiment of this kind, one experiences an indescribable feeling when he again stands in front of this simple mast—this rudimentary instrument of so delicate a transmission. Whether it be wet by fog or mist, or dried by the wind, it is always ready to receive the unknown vibrations that a similar mast has sent into space.

EXPERIMENTAL STATION AT WIMEREUX—RECEPTION OF A TELEGRAM FROM ENGLAND.

**Statistics gathered** by the United States Geological Bureau show that the production of paving brick increased from 320,407,000 in 1896, worth $2,794,585 or $8.72 per thousand, to 435,851,000 in 1897, valued at $3,582,037, or $8 22 per thousand. The vitrified brick product shows the greatest increase in the clay industry. The sewer pipe product decreased from $4,588,503 in 1896 to $4,069,534 in 1897.

## ABOUT LAUNDRY BLUES.*

LAUNDRY blue is sold commercially in cakes of various shapes, in powder and in a liquid form. The balls and powder may be considered as the same thing in use, as the former are simply the latter compressed and molded. Almost all writers on the subject, French and English, the most practical men, agree that the preferable form is the solid, and not the liquid, blues. The reason generally assigned for this preference is that the blue in a solid form is much purer than the other, but from what the writer knows of manufacturing processes, he is much inclined to doubt this, although for other reasons, which will presently be touched upon, he believes the solid form is the better. As for the particular nature of the color used, there is plenty of choice, for nature is prodigal in blue coloring matters. In describing these, the general fault of laundry text-books is that they give more or less correct information on each particular color, but not from the point of view of the way it is manufactured for laundry purposes. There is very little use in telling the laundryman merely what indigo is and the nature of it. What he wants to know is how it is put up for his use, and this is what the writer proposes to tell him. The blues ordinarily used for preparing the article for the laundry are indigo, artificial ultramarine, various forms of Prussian blue, and the coal-tar colors commonly called aniline. We will describe these individually from the point of view which we have stated.

### INDIGO.

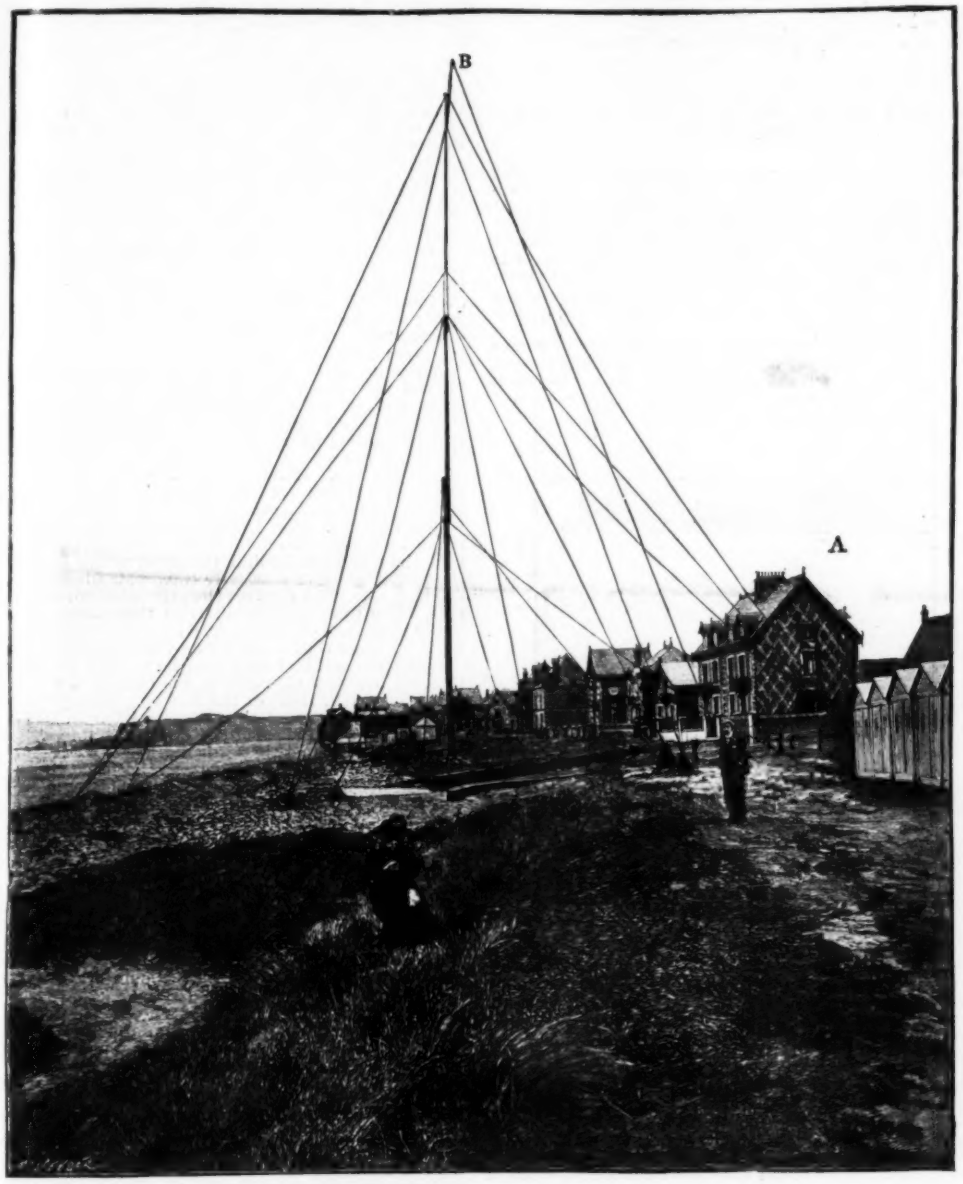
Indigo is perhaps the oldest of laundry blues, and held the field almost entirely until artificial ultramarine was first prepared. Now let us sweep away an

* London Laundry Journal.

error that we find in two excellent laundry text-books, one English and one French, and both of recent date. Indigo is entirely insoluble in water, and, moreover, in solid laundry blues, there is nothing in the twenty or thirty practical manufacturing recipes which the writer has seen to make the indigo soluble. The fact is that for the laundry, the indigo is in as finely divided a state as possible, and mixed with other substances, generally inert bodies, such as terra alba and barytes, which keep it so and enable the microscopic particles to remain in suspension in the water. A typical manufacturing recipe for an indigo laundry blue gives twenty-four parts of terra alba and barytes in equal proportions, and one and a half parts of indigo. A thumb blue, sold in tremendous quantities, is extract of indigo and china clay mixed together and molded into shape. These inert bodies must not be looked upon as adulterants, for the laundryman could not stand the cost of pure indigo, and it would not be good for his purpose.

### ARTIFICIAL ULTRAMARINE.

Ultramarine is an extremely expensive natural blue —lapis lazuli. As it is worth at least its weight in gold, it is not exactly likely that we should meet with it in laundry blues. The artificial product, which we will henceforth speak of simply as ultramarine, is quite a different thing. It is merely china clay to which color




THE WIMEREUX TELEGRAPH MAST (FRENCH COAST).

A. Building containing the telegraphic apparatus. B. Transmitter and receiver of the electric waves.

has been given by burning it with resin, sulphur and soda. It is comparatively a recent discovery, but Germany, where it was invented, has already found a formidable manufacturing competitor in Great Britain. The extent to which it is manufactured in England, in fact, is a source of congratulation, and now, perhaps, it is the commonest used laundry blue. The ultramarine itself can vary between twenty and thirty pounds per ton in round figures, and it is only one of the ingredients of ultramarine laundry blues, which shows very clearly that there is plenty of room for an enormous variety of qualities. The best blues made with this article are composed of a high quality of ultramarine mixed with about two-thirds its weight of bicarbonate of soda, and a fifth its weight of glucose as a binding substance. From this high grade we can descend to a low grade of ultramarine mixed with more than its weight of blue earth and liberally adulterated with terra alba. The English ultramarine is more reliable than the German article, and the best China clay for the purpose is found in Cornwall. Manufacturers, therefore, should most certainly use the native article in preparing laundry blues. If they do not do so, it is merely a question of cost.

### PRUSSIAN BLUE.

Chemically speaking, Prussian blue is a well-defined compound, ferri-ferrocyanid; commercially, it is all sorts of things. When yellow prussiate of potash is added to a ferric salt, a most beautiful blue is instantly produced, and this is the Prussian blue of the laboratory. The manufacturers' Prussian blue, which is sold under a host of names—Paris blue, Chinese blue, celestial blue, etc.—always contains diluents, and often positive adulterations. For instance, a typical recipe for possibly the best commercial Prussian blue is two parts of yellow prussiate of potash added to two parts of ferrous sulphate and one part of alum. The alum is purely and simply a diluent. As a matter of fact, this would be a fine quality of blue, especially compared with some of the pigments on the market; for instance, an eighteen hundredweight batch, according to one manufacturer's receipt before the writer, contains sixteen hundredweight of inert substance (barytes). There is plenty of choice, therefore, in the matter of Prussian blue used, and this again is only one of the ingredients of a Prussian blue laundry blue. Prussian blue is usually the base of absolutely the cheapest qualities of laundry blues. For instance, one is made from the most economic Paris blue mixed with its own weight of equal proportions of potato starch and wheat flour refuse.

Like indigo and ultramarine, Prussian blue is insoluble in water, and it is generally prepared in its liquid form by adding oxalic acid. For example, one part of oxalic acid is added to eight parts of Prussian blue, and the whole is made into a solution with just sufficient water to dissolve it. This is the plan followed generally with liquid blues, and it shows at once that they are to be avoided as a class. Oxalic acid is a poison, and might cause serious mischief.

It is true that very good liquid blues can be made, and those sent out by reputable firms would be free from suspicion. For instance, one liquid blue on the market is made from extract of indigo mixed with an equal quantity of Glauber's salt (which is perfectly harmless) and dissolved in water. If for some reason the laundryman has a distinct predilection for liquid blue, the writer strongly recommends him to make it himself. The best way is to keep in stock rather dilute solutions of iron chlorid and of yellow prussiate of potash, and to mix them immediately before use. This should be done in proportions gaged by experiments which will make a strong blue (apparent) solution without giving a precipitate. Still, we believe that there is nothing to recommend a liquid blue, with the single exception that it is more easily used.

### ANILINES.

A large variety of anilines now find their way into blues. A soluble aniline blue, however, would not correct the yellow tint and produce a white, which of course is the object of all bluing, but would mingle with it and give the clothes a greenish hue.

Possibly the first aniline used in bluing, at any rate by the bleachers, who have to correct the yellow cast of their goods in the same way, was a violet soluble in alcohol and insoluble in water, and to this a little French purple was added. A German writer surmises that this has gone out of existence, because it can no longer be made on a remunerative scale, as more suitable violets for dyeing purposes have superseded it and the use for bluing alone would not give the makers a payable return. Since this insoluble violet is not procurable, methyl-violets mixed with a purple aniline have been principally used, but all this class of dyestuffs are not equally suitable for the purpose, and it is said that the one known as violet No. 350 is the best. Especially with anilines, some laundrymen have generally passed the linen after bluing through an acidulated bath to fix the blue, but this is a process most decidedly to be deprecated.

As we have said, indigo, ultramarine, Prussian blue, are all absolutely insoluble in water. The idea that indigo is soluble possibly arises from the fact that it is used to an enormous extent as a dyestuff, but before introducing his goods into the vat the dyer has to add ingredients which reduce the indigo to a soluble body, in which state it is white. Even the apparent solution of Prussian blue, got by mixing yellow prussiate and an iron salt together, is not a real solution. The indigo is held in suspension in the water in extremely finely divided state. At the recent Brewers' exhibition, a solution of Prussian blue, prepared in this manner, was passed through the kiselguhr filter to exhibit its powers and colorless water filtered out, leaving the solid matter behind. It is true that indigo-carmine, which is prepared by dissolving indigo in the strongest sulphuric acid, diluting with water, and neutralizing the acid with chalk, is soluble, and forms the basis of some liquid blues, but when indigo itself, ultramarine, and Prussian blue are used for liquid blues, they are invariably rendered soluble by the addition of oxalic acid.

However, the writer is disposed to think that an insoluble blue capable of being held in suspension in an extremely divided state is exactly the thing the laundryman requires. In this way the blue is deposited on the surface of the clothes just where it is required for the correction of the yellow tinge in the most economic manner, and there is no need for it to penetrate and slightly dye the fiber as a solution would. This, therefore, is another reason why the solid form is preferable.

The process of manufacture is very simple. The material is ground up in edge runners under heavy granite millstones to as fine a powder as possible. Apart from the quality of the materials used, the excellence of the blue depends upon its state of fineness. It is then molded into the shape desired by hydraulic power, and is ready to send out. The thumb blue is usually coated with an aniline powder of Prussian blue dust to give it a good appearance, and the bottoms of some makers' cakes of blue are polished by simple means, but these little refinements have no effect on the quality of the blue. The point is, it should be in an extremely divided state, and when sent out in the form of a bag blue, it should be inclosed for use in a closely woven cloth. The rest lies with the laundryman.

It must be remembered all these bodies are very heavy, even in a finely divided state, and, therefore, inclined to deposit. The laundryman's object is to keep the blue he uses in a state of uniform suspension, and, like the proportion to be employed to get the best results, this can only be learned by experience. However uniformly the work is done, the insoluble nature of these blues entails a tendency to streak if there is any delay in hydroing, and it is difficult to see how this could be corrected.

As for the choice between the four kinds of blue ordinarily employed, it would seem to be simply a matter of cost, but the writer would prefer the base should be either indigo, ultramarine, or a thoroughly good Prussian blue. All these fill the required conditions of bluing. They are extremely fast to light; in fact, as a result of recent experiments, Prof. Hummel declares Prussian blue is the fastest of all dyes on wool to light, although it is unsuitable for that purpose because of its sensitiveness to alkalies. The fastness of indigo to light in this respect is too well known to need comment, and ultramarine leaves nothing to be desired. Their insolubility causes them to correct the yellow cast of the clothes on the most economical terms; that is to say, without waste.

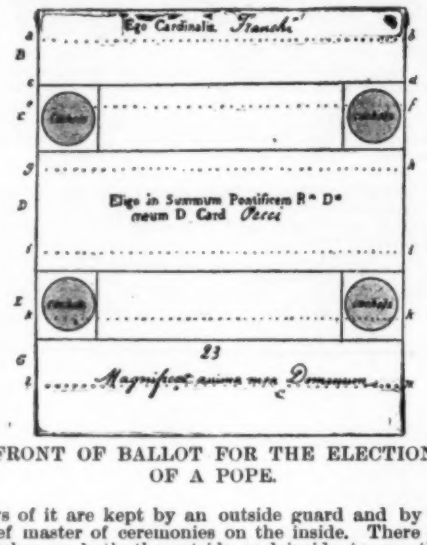
## HOW A POPE IS ELECTED.

"THE Bishop of Rome is the Pope of the Church Universal." Such is the ecclesiastical dogma upon which the choice of the head of the Roman Catholic Church depends. The mode of choosing the successor to a deceased pontiff has always been by election, and the exceptions to this rule have been extremely rare. In the very early Christian times the founders of the church, in order to insure an organization as complete as possible, designated the successors before their own death; thus, Linus, Cletus, and Clement, the direct successors of St. Peter, were in some degree coadjutors of St. Peter, and he designated their order of succession. In the Orient this system, which was called "testamentary," seems to have been more used than in the Occident, but in 341 the Council of Antioch formally forbade this procedure. The true canonical method of providing for the successor to the chair of Peter was, during the first centuries of Christianity, an election in which the clergy, the people, the bishop of the province, all played a distinct rôle, and for seven centuries after the death of Constantine the election of the Pope was required to be confirmed by the Emperor. It was Nicholas II. (1058–1061) who first proposed to restrict the right of electing the Pope to the cardinals of the Holy Roman Church, the choice, however, to be confirmed by the church and people, and this plan was tried up to the reign of Alexander III. (1159–1181), who, by the advice and with the approval of a General Council held in 1170, ordained that, in consequence of the number of persons entitled to have a vote in the election of the visible head, and in consequence of eighty-three schisms by which the church was "lacerated," the cardinals alone should choose, ap-

point, and enthrone the successors of St. Peter, to the exclusion of the vast body of clergy and laity. It was stipulated that the suffrages and votes of two-thirds of the cardinals must be given to any one man before he could be declared a properly elected Pope, and after the schism which ended at the Council of Constance, the Pope has always been chosen by the cardinals united in conclave. "Conclave" is derived from three Italian words, "*Chinso con chiare*," which means "closed by keys." The conclave is, therefore, the place where the cardinals assemble to choose a Pope. Formerly the conclave met wherever the Pope chanced to breathe his last, but Pope Clement VII. issued a bull which ordered that, should a Pope die away from Rome, his successor should be chosen only in Rome. The method of holding the conclave has been much discussed by high ecclesiastical authorities, and in 1877 Cardinal Pecci, who afterward became Pope Leo XIII., convoked a special commission of cardinals who were charged with formulating new rules for the conclave. They directed that all intervention of secular power or influence be excluded. If the Pope dies at Rome, the cardinals are to decide by a majority of votes if the election is to take place at Rome or away from Rome; and if the number of cardinals present represent one more than a half of the members of the Sacred College, they can, if they so desire, proceed immediately with the election. The conclave can be dissolved and transferred out of Italy if the necessity arises. Various other minor rules were made to regulate the election.

When the malady of the sovereign pontiff appears to be very grave, the Cardinal-Dean sends for all the cardinals to the Apostolic Palace, and the Cardinal-Vicar, who is chief of the diocese of Rome, orders prayers in all the churches. The Secretary of State also notifies the diplomatic corps. When the Pope does not die suddenly, he calls around him all of the domestic prelates and dignitaries of the pontifical family. The cardinals unite around his bed; the Cardinal Grand Penitentiary assisting the pontiff with his confessor, and the Bishop-Sacristan brings him the viaticum, after which the Grand Penitentiary recites the profession of faith and pronounces on him the supreme absolution and the formula of indulgence, the "*in articulo mortis*." As soon as the pontiff dies the Chamberlain gives orders to clear the palace and the death chamber of all strangers, and his second act is somewhat in the nature of the function of a civil officer. Dressed in violet, the Chamberlain enters the death chamber and for the first time touches the body of the deceased. The head is covered with a white veil. After a short service the Chamberlain approaches the bed and the veil is raised, then with a small silver mallet the cardinal strikes three blows on the forehead of the deceased and calls him three times by his baptismal name. Then the Chamberlain turns to his companion and says that the Pope is truly dead. At this moment one of the ecclesiastics takes the famous ring of the fisherman from the finger of the deceased Pope, and gives it to the Chamberlain, which is a sign that the authority of the Holy See is in the hands of the latter, who also breaks the seals. The ring is broken and a new one is taken to the altar, where the last and decisive vote is taken. This shows that the papal jurisdiction symbolized by this ring remains suspended; the official seals are also destroyed. The Protonotary kneels at the foot of the bed and reads the paper which is drawn up, which states in legal form (a *procès-verbal*) that the Pope is actually dead and that the body has been duly recognized and that the symbolic ring is in the hands of the Chamberlain. When these formalities are terminated the Chamberlain retires into one of the neighboring rooms of the pontifical palace to make the official notifications for the mourning in the church. Formerly when the church had authority over Rome the great bell of the capitol was tolled announcing to all the people of the city that the Pope was dead, the bells of all the churches in the city responding in chorus, but, however, this would probably not be done to-day. Notification of the death is also given to the people by a notice of the Cardinal-Vicar affixed to the doors of the churches. Notice of the death of the Pope is sent to cardinals of the other parts of Italy and in other countries by the quickest means. In 1878, when Pius IX. died, the telegraph and cable were freely used in giving the news. Various other matters of minor importance are also attended to. The Chamberlain, from the moment he leaves the death chamber, is accompanied by members of the Swiss Guard, who do not cease to render him honors as the master of the palace until the conclave is begun. After the Chamberlain has left the death chamber care is given to the body of the Pope. Two great candelabra are placed at the head and foot of the body and members of the Garde Nobili maintain guard with the points of their swords to the ground. The body is embalmed twenty-four hours after the death of the Pope, after which it is dressed in the usual clothing of his rank. The body is next taken to the Sistine Chapel and afterward to St. Peter's with a procession and great ceremony. Here the body lies in state in the chapel of the Holy Sacrament for three days and is visited by a vast number of people. For ten days funeral services are held daily in St. Peter's Church and then the body is placed in a temporary resting place. The body is inclosed in three coffins, which are carefully sealed by the proper ecclesiastical officers. The coffin is placed in a provisional sarcophagus, usually over one of the doors in St. Peter's Church. The noble simplicity which characterized the funeral of Pope Pius IX. made a profound impression. Some of the funeral ceremonies and devices which have been introduced during the seventeenth and eighteenth centuries were abandoned, adding greatly to the solemnity of the occasion.

The provisional government of the church during the vacancy of the throne of Peter is in the hands of the Sacred College and is administered by the Cardinal-Chamberlain and by a triumvirate of cardinals. As already stated, the inferior clergy and the people have now no voice in the election of the Pope. The conclave may begin on the eleventh day after the death of the Pope, or they may wait for a much longer time. On the appointed day they collect in St. Peter's Church and the Cardinal-Dean celebrates the mass of the Holy Ghost, after which the cardinals in procession, singing "*Veni Creator Spiritus*," march to the place where the conclave is to be held, and the constitution governing the conclave is read and the cardinals take an oath to obey it. During the remainder of the day the cardinals are free to receive their friends, but when the evening comes the friends depart, the cardinals are shut up, and the conclave begins. There is only one entrance to the conclave, all the rest being walled up, and the one door is closed and is locked with two keys, one of which is kept by the Chamberlain and the other by the hereditary marshal. A turning box is built into the door through which food is passed and the




FRONT OF BALLOT FOR THE ELECTION OF A POPE.

keys of it are kept by an outside guard and by the chief master of ceremonies on the inside. There are watches on both the outside and inside to see that no letters nor messages are brought in which will give any information relative to the conclave or which will tend to influence the cardinals, and even the food is examined. Each cardinal is entitled to have two servants, and a third if he is very feeble. There are also a number of other persons, such as secretaries, physicians, barbers, etc.

The conclave was formerly held in a suite of rooms and there were wooden booths arranged in the largest hall of the conclave. There is one booth for each cardinal and over the door of each booth there was

BACK OF BALLOT.

placed the coat of arms of the occupant. Whether or not a cardinal goes into conclave, he is expected to pay for his cell, which is very expensive. The cardinals are now virtually prisoners in their cells. In 1878, however, when Leo XIII. was elected, the system of cells was given up and a large number of rooms was made by partitions.

On the first morning of the conclave the Cardinal-Dean says the mass of the Holy Ghost, at which the cardinals receive communion. This mass is said in the Pauline Chapel. Then they proceed to vote—usually in the Sistine Chapel. Only the cardinals are allowed in the chapel at this time, but, if a cardinal arrives late, he is admitted, but none must leave the conclave unless

BALLOT AFTER SEALING.

they are very ill. Three cardinals, one from each order, are selected to act as tellers. Each takes the following oath at the altar: "I call upon God, who will be my Judge, to witness that I choose the person whom, before God, I judge ought to be elected, and that I will do the same on the accession." And, having so sworn, they drop their ballots into a large golden chalice covered by a paten. The ballots are of peculiar form, and our engravings illustrate how they are made and folded.

The ballot consists of a piece of paper, headed by the words "*Ego Cardinalis*." The cardinal fills in his name on the blank, so that it reads, "I, Cardinal [Franchi];" then in the center space are the Latin words meaning "I choose for Supreme Pontiff the Most Reverend Cardinal [Pecci.]" Then the upper part of the ballot is turned down and sealed so that the name of the voting cardinal is concealed. On the lower part of the ballot is a blank space, on which the cardinal writes a Latin line and a number, to serve as a cipher. This is also turned over and concealed so that only the name of the cardinal who is being voted for is exposed to view. The whole is then folded exactly in the middle, concealing even the name of the cardinal candidate. The first teller, who is a Cardinal-Bishop, takes out the ballot, opens the first fold, and reads the name of the candidate. This is then passed to the second teller, who is a Cardinal-Priest, who, in turn, hands it to the third teller, a Cardinal-Deacon, who reads aloud the name of the candidate, the cardinals keeping tally on printed lists. If it is found that no candidate has a two-thirds vote, which is called the "scrutiny," a second ballot is held at once. All the cardinals are obliged to vote, but they need not change their ballots unless they desire. A somewhat similar form of ballot is used. The second ballots are called the "accession," and Popes are usually elected by accession. The tellers open the new ballots and place them alongside of the ballot first cast, the lower portion being open so as to expose the cipher, which must be used throughout the conclave by the cardinal after he has once adopted it. When an accession ballot is for the same person as the first ballot with the same cipher, it is not counted, but if a different name is found, the accession ballot is counted and the original ballot is discarded. If one of the cardinals is found to have just the two-thirds required, the ballots are opened so that the name of each voter may be seen, and if the candidate has voted for himself, it is not counted, so that he still lacks one vote for election. The ballots are then burned, and a second ballot is taken in the afternoon. The smoke caused by the burning ballots is anxiously watched for by those in the streets contiguous to the Vatican, and when they see smoke coming out of the chimney they know that the ballot has been taken without effect. Balloting twice a day goes on for days, weeks, months, and, in some cases, years. After each ballot the cardinals retire, and in time all cliques are broken up, and until, as they say, the "Holy Spirit lightens the hearts of men." Usually the election is made in from one to five days, but Clement V. (1305) was elected by a conclave which was in session two years, three months, and seven days, where his successor was elected in seven days. In this century the conclave at the death of Pius VII. was in session twenty-six days; Leo XII., one month, eight days; Pius VIII., one month, twenty-three days; Gregory XVI., twenty-six days; Pius IX., two days.

When one candidate has the necessary two-thirds of all the votes cast, the Cardinal-Dean announces his name, the bell is rung and the master of ceremonies or secretary enters the chapel. Then the Cardinal-Dean and two other cardinals approach the newly elected Pope and ask him if he is willing to accept the result of the election. If he does so, the canopies over the cardinals' thrones are taken down by means of ingeniously disposed cords, except the one over the new Pope, which remains. The Cardinal-Dean asks him what name he desires to assume and two Cardinal-Deacons lead the new Pope behind the altar, where he puts on the pontifical vestments. He then seats himself before the high altar and receives the salutations of the cardinals. The Cardinal-Chamberlain then places the ring of the fisherman on his finger, which the new Pope gives back, in order that his name may be engraved upon it.

When the cardinal says that he will accept the election, he becomes officially in his church the Vicar of Christ on earth, Head of the Bishops, Bishop of Rome, Supreme Governor of the Catholic Church, Patriarch of the West and Prince of the Pontifical States.

It is a curious fact that it is not necessary for a Pope to be a priest. Laymen have even been chosen Popes, subdeacons have been, and one of the greatest of all the Popes, Hildebrand, was not ordained a priest until after he had been chosen Pope.

The newly elected Pope, preceded by musicians and the choir singing "*Ecce Sacerdos Magnus*," goes to the balcony, preceded by the Cardinal-Dean, who announces the election to the people with the formula, "I announce to you a great Joy. We have as Pope the most eminent and most reverend [here the name of the cardinal is given], Cardinal of the Holy Roman Church who has taken the name of ————." The Pope then blesses the city and the universe, "*Urbi et Orbi*."

The enthronization of the new Pope is an occasion of great ceremony. Early on the appointed day the cardinals salute the Pope and a procession is formed to conduct His Holiness to the great basilica of St. Peter's, the largest church in the world. First comes the choir, then the lower clergy, then the bishops, archbishops, and cardinals, according to their rank and also in order of seniority in their rank, and finally, borne aloft in a chair, comes the new Pope, and all around the clergy march members of the various Swiss Guards in their strange uniforms and the Noble Guard. The procession moves majestically up the central aisle and halts at the chapel of the Most Holy Trinity, where the Pope adores the Host. The Pope then proceeds to the east side of the high altar, where he alights. After a prayer at the foot of the altar, he ascends the steps and seats himself on the altar, where the ciborium or tabernacle is placed. The cardinals then advance and make obeisance to him, three times prostrating themselves and kissing his slipper. Rising, they kiss his hand and then receive two embraces. The Pope then blesses the people and leaves the altar.

On the Sunday after the consecration occurs the coronation, which also takes place at St. Peter's. The Pope says mass, and then, after donning the pontifical mantle, goes to the balcony over the great doors of the church. The Cardinal-Deacon then removes the pontifical mantle and places the tiara on the Pope's head. The Pope then makes two prayers and retires in state.

Formerly, on the appointed day the Pope went to his cathedral church, which is not St. Peter's, but is St. John Lateran, where he was enthroned, not only as Bishop of Rome, but as Patriarch of the West. It is doubtful if the next Pope will make this trip to St. John Lateran, as the Popes now consider themselves as prisoners within the confines of the Vatican as soon as they are elected.

The splendid ceremonies which mark the death and funeral of the Pope, the election, consecration, and coronation of his successor, are one of the most interesting customs in the world and are interesting to all, without reference to religious belief.

## TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

**Electrical Works in Brussels.**—Consul Roosevelt writes from Brussels March 13, 1899: Statistics show that in 1893, 3,030 lamps met the requirements of consumers of electricity in the city of Brussels. At the present time, there are 66,000 lamps. In consequence of the constantly increasing use of electricity, the city has been obliged to enlarge its works. It is now proposed to acquire five new vertical machines of 1,000 horse power, to be placed in works already supplied with five horizontal machines of 500 horse power. The city also has electrical works established in the basement of the railroad building; but, owing to the steadily increasing use of electricity, the production is insufficient to meet public demands. In consequence, it has been decided to unite the two works by means of four cables inclosed in iron pipes. It was at one time proposed to erect a large electrical power house just beyond the city limits; but, as it was shown that about 15 per cent. of the current would be lost, the proposition was rejected. The most practical method now seems to be the creation of new stations as the exigencies of the situation may demand.

**English Market for Berries.**—Consul Brush writes from Clifton, under date of March 16, 1899: Mr. C. C. James, deputy minister of agriculture for the Dominion of Canada, is in receipt of the following letter from Mr. Harrison Watson, curator of the Imperial Institute. It indicates that fruit men may find a profitable market in England this year. Mr. Watson says:

"I am keeping track of the raspberry-pulp trade. I learn that the Australian crop has again been practically a failure. One broker states that they are asking £45 to £50 per ton, and others that the Australians will have none to export. It is still too early to attempt to foretell the course of events, as everything must depend upon the English and Dutch crops. Speaking guardedly, I should think that the prospect for fairly high prices is on the cards, and Canadian raspberry packers should watch the market."

**Exports of Cutlery to Cuba.**—Consul Johnston writes from Sheffield, March 9, 1899: The value of declared exports to Cuba from this district last month was £173 10s. ($844.33). The articles shipped were penknives, with ivory, pearl, shell, and stag scales; razors with bone and ivory handles; and scissors. The shipments were made to Havana as the port of entry.

**Projected Railroads in Norway.**—I submit the following information, which I believe will be of interest to our manufacturers, says United States Consul Victor E. Nelson, of Bergen. I hope that at least some of the contracts will be secured by them, and I am willing to do anything in my power to aid them in supplying the prospective demand for rails, locomotives, cars, railroad tools, etc.

It may be well to add that, as our merchants will have to compete with English and German manufacturers, it would be advisable to allow the same credits (from sixty to ninety days) as these houses give.

The board of public works has proposed an extension of the Norwegian railroad system, and the basis of construction is a public loan of about 48,000,000 kroner ($12,864,000)—12,000,000 kroner ($3,216,000) a year for the next four fiscal years. This plan, however, has the proviso that if the stations on the Ofot and the Christiania East lines are not included in this work, the loan will only be 8,000,000 kroner ($2,144,000) a year for the next four fiscal years. Some of the government officials desire to reduce the estimates to 5,000,000 kroner ($1,340,000) a year, on account of financial considerations.

According to the foregoing plan, the different lines will be opened for traffic as follows:

| Line. | Year. |
|---|---|
| Sandaker-Rökenviken | 1900 |
| The north lines | 1902 |
| The Ofot lines | 1902 |
| Ekersund-Flekkefjord | 1903 |
| Bergen-Gulsvik (the northern part of Kröderen) | 1904 |
| Hell-Sunde | 1904 |
| Bergen's line | 1907 |
| Arendal-Amli | 1907 |
| Part of this line | 1903 |
| Extension of Solör line to Elverum | 1907 |

In addition to the above, the following plans for construction have been submitted for investigation and consideration by the department:

Trunk lines to Christiansand, Kongsberg (or Skollenberg), Honefas, Gjövik, Sell, Stören, Drontheim, Grong, and Mosjöen; side lines connecting these with the Romsdal and Sundal fjords and Namsos; and, lastly, extension of the Bergen lines to Hardanger and Sognefjord.

It is easy to see that a large amount of the railroad supplies will shortly be needed here (to say nothing of the bridges which the nature of the country renders necessary), and it would pay our manufacturers to endeavor to obtain some of the contracts.

**American Horse Meat in Norway.**—Consul Nelson, of Bergen, sends, under date of January 23, 1899, the following translation of an article in the Bergen Aftenblad:

"A recent edition of an American newspaper contains an article on the horse meat trade in the United States. The article says that there is a large factory of horse meat at which inspectors rarely, if ever, call, as the firm has given a guaranty not to sell horse meat in any form in the United States. It is known, however, that this firm has shipped large quantities of horse meat to Norway, where it is much sought after as a delicacy. This delicacy—to say the least about it—is of a rather doubtful nature; for, according to the newspaper referred to, old horses and mules are used for meat purposes. The meat is cut, salted, packed, and then shipped to Christiania. The newspaper officials have tried to find out more about this trade. We know for certain that a large amount of horse meat is imported from America and England. It is cut into pieces, salted a little, and packed in barrels. Large quantities of this meat are used in sausage factories. It is impossible to inspect this meat properly or to ascertain whether it comes from sick or 'dead' horses. Then, again, as this meat is cut in small pieces, a barrel can contain both good and bad. In only a few cases are the recommendations of the health authorities obeyed with regard to these 'delicacies.' This is evidently a very unjustifiable method of procedure. The best and most natural way would be to forbid the importation of horse meat; but if we do not carry the matter so far, we ought to take some other measure. There should be a health certificate on all kinds of meat, and this should be signed by the Norwegian consul. Furthermore, the meat should not be imported in small pieces, and not less than one-half or one-fourth of the animal should be admitted."

A copy of the above was referred to the Department of Agriculture. The Department says in reply:

"The meat of horses is entitled to the same inspection in this country as that of other animals. If the government of Norway is suspicious of the character of the horse meat shipped to that country from this, it might require that such meat be accompanied by a certificate of inspection by the officers of this government. In that case, there would be a certainty that the meat was the product of horses in good condition as to health, and that the meat was sound and wholesome at the time it was inspected."

**American Boots and Shoes in Denmark.**—I consider the present moment most opportune for the introduction into Denmark of American boots and shoes, as the tendency to use ready-made shoes is increasing rapidly, since the difference in price with those made to order is becoming marked, says United States Vice-Consul Jules Blom, of Copenhagen.

The import of foreign-made shoes increases steadily, as will be seen from the following figures:

| | Pounds. |
|---|---|
| 1889 | 194,502 |
| 1891 | 208,663 |
| 1893 | 311,866 |
| 1895 | 364,445 |
| 1897 | 379,452 |

Austria, Italy, Germany, and, to a small extent, Great Britain, control this market; but there is no reason why our manufacturers should not secure a large share of this trade, as their goods are well finished and elegantly shaped. Pointed and narrow shoes will not sell here; the Danish foot is large. Our manufacturers have studied the German markets, and I think the same styles will find favor here.

Several of the Danish shoe manufacturers have imported American machinery, but the Danish duty on shoes being very light (it varies according to the quality, and I fear it would be misleading to quote it), our manufacturers can, no doubt, compete in price.

Denmark has a population of about 2,350,000 inhabitants. The Danish shoe manufacturers produce about 4,000 pairs of shoes daily. The imports of foreign shoes are about forty per cent. of the whole consumption.

Manufacturers should address: The Wessel & Vett, 13 Kongens Mytorv; Skandinavisk Skotöjsmagasin, 35 Ostergade; E. Oettinger, 44 Ostergade—all of Copenhagen.

Mr. Johan Lund, 4 Lexegade, Copenhagen, is willing to accept agencies.

The commercial agency of R. V. Fournais & Company, Copenhagen, will for a small fee rate any firm in Denmark.

**Commercial Education in Antwerp.**—Consul-General Lincoln sends from Antwerp, February 25, 1899, an article taken from The Belgium Times and News of even date, giving an account of the higher commercial institute of that city, which is summarized as follows:

"The students are divided into two classes—the 'regular' and the 'free.' The former attend all the lectures with a view to obtaining a diploma at the end of two years, which period constitutes the prescribed course of study, except for those preparing for the Belgian consular service, for whom a third year's course has been added. The 'free' student follows only the courses of lectures which he considers of importance to his commercial career.

"The instruction is practical as well as theoretical. The transactions of commercial and counting houses are practiced, and all questions relating to the theory of exchanges are accurately described. The correspondence of the 'office' must be conducted by the student himself, and that, too, in French, German, and English, which languages are obligatory. He must also be competent to correspond in one other foreign language, the choice generally being from the Spanish, Italian, or Dutch. The Russian language is also taught; its study is not obligatory. The principles of political economy, of international commercial law, and of customs legislation are also inculcated. The geographical and economical conditions of foreign countries are studied from carefully compiled data, and the relative value of raw material, from different sources of supply, is inquired into and noted.

"The student is also encouraged to take a close interest in the political events of the day, so far as these affect commercial interests; and the latest consular reports from all countries are placed at his disposal, so that he himself later on may be in a position to make a report upon the commercial prospects of any country in which he may happen to be.

"Another important feature of the Antwerp institute is the bestowal of traveling scholarships on the most deserving students of Belgian nationality. A sum of nearly £2,000 per annum is devoted to this object. A student who has passed his final examination with credit is entitled to offer himself as a candidate for one of these scholarships or 'bourses,' as they are called. If one be granted, he proceeds abroad, with the certainty of enjoying, for three years at least, an annual income of about £200. He is thus relieved of the necessity of accepting the first situation that is offered to him and can devote the whole of his time, if necessary, to the study of the economic condition of the country in which he resides. He must periodically send home a detailed report of the result of his observations. By his previous training, he is enabled to do this effectively; and these reports, after being noted by the government, are utilized by the students in the prosecution of their studies.

"Down to the end of 1892, 62 students had been thus sent abroad; the countries chosen for residence being Algeria, Morocco, the Cape, Japan, China, India, Canada, the United States, the Argentine Republic, Brazil, Colombia, Venezuela, Chile, Mexico, Cuba, Philippine Islands, Australia, and New Zealand; in fact, those countries in which Belgium is seeking to place her manufactures. Of these 62 students, 27 have remained in the countries to which they proceeded, and are now doing well as merchants or commercial agents; 16 are established in European countries, also as merchants; and 2 have entered the service of the Japanese government as teachers of the commercial sciences.

"It will now probably be asked what is the cost to parents of a higher commercial education, such as that given at the institute at Antwerp. It is very small, the expenses of maintaining the establishment being borne by the Belgium government in part and the rest by the Antwerp municipality. Each student pays a fee of about £10 the first year and £12 the second, the total amount thus raised being given as honorarium to the professors to supplement their salaries.

"The government does its best to procure a really competent teaching staff, and pays so much a year to each 'chair,' giving a pension to the professors after a certain number of years' service."

**Scottish Criticism of American Linseed Cake.**—Consul Fleming, of Edinburgh, under data of March 20, 1899, writes: Since January 1, 1899, there have been imported from the United States to this market 26,000 bags of cotton-seed meal and 8,000 bags of cotton-seed cake. While the sales of our cotton-seed products here have become important and are increasing, the linseed cake imported is almost wholly Russian. I have asked dealers in these articles why American linseed cake has not yet competed successfully with the Russian product. The answer uniformly given is that too much of the oil is taken from the American linseed cake in the process of crushing; in other words, as one commission merchant puts it, "the life is crushed out of the cake." It is the common opinion here that if the American producers of linseed oil would "ease up" the crushing machines, competition with Russia for the trade in linseed cake would not be nearly as difficult as it is at present. I am simply offering the Scottish dealers' view of the subject as a suggestion, which may or may not be new or practicable.

**Hindrances to British and American Trade in China.**—Consul Fowler sends from Chefoo, under date of February 6, 1899, a newspaper containing the memorandum of the British China Association and an account of the proceedings of the American Association at its first meeting. The British memorandum, it is stated, was drawn up by the committee in deference to a suggestion by Lord Charles Beresford that the association would strengthen his work by circulating a statement of its views upon the present situation in China as affecting questions of trade and commerce. The memorandum begins by attributing the slow progress made in the development of foreign trade with China to three main reasons, namely: (1) The entire absence of good faith on the part of China in the matter of treaty obligations; (2) the absence of security for the investment of foreign capital in China anywhere outside of the treaty ports; (3) the general apathy and want of knowledge which has in the past been displayed regarding Chinese affairs. As an illustration of the absence of good faith on the part of the Chinese government, the failure of the transit pass system is cited. So long ago as 1858, provision was made in the Tientsin treaty that on the payment of an extra half duty, transit passes could be obtained under which imports and exports could be transported to and from the interior exempt from all further inland charges whatever. The memorandum says that these privileges are universally ignored and exist only in name, the additional taxes levied by local officials on the goods throughout the empire causing a practical stoppage of trade in many directions.

France and Germany, it is pointed out, have of late been more successful in enforcing their treaty rights. The British China Association thinks that the only way to obtain satisfaction is to deal with abuses where they occur and face Pekin with the fact of grievances already redressed. Speaking of one of the most recent concessions—the right to navigate inland waters in China—the memorandum points out that the permission is utterly futile, so long as liberty of residence for purposes of trade is withheld, except at the treaty ports. It is obvious, says the memorandum, that for the protection of merchandise transported by foreign craft under foreign control, there must be established upcountry stations and depots where foreigners or their agents can reside, for the management of the traffic and for the storage and delivery of goods. Other restrictions on the concession likewise limit its value.

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## INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

**No. 396. April 10.**—Argentine Tariff Changes—Shanghai Imports from United States—Cultivation of Rushes for Mats in Japan—Russian Council of Commercial Navigation—*Scottish Criticism of American Linseed Cake—*Exports of Cutlery to Cuba.

**No. 397. April 11.**—Germany's Wine and Grape Trade in 1898—Iron Nail Trade in Japan—Japanese in Foreign Countries—Copper Trade in Japan—Sesame in Syria—*English Market for Berries.

**No. 398. April 12.**—The World's Coffee Trade in 1898—Emigration from German Seaports in 1898—*American Horse Meat in Norway—Coffee and Sugar Crops in Java—Sickness at Dawson City—German Telephone Service—Production of Wine in Algeria.

**No. 399. April 13.**—Mines in Shantung—*Hindrances to British and American Trade in China—Dynamite Factory in the Transvaal—*Chart of Russia at Paris Exhibition—*Electrical Works in Brussels.

**No. 400. April 14.**—Russian Petroleum Trade in 1898.

**No. 401. April 15.**—*Projected Railroads in Norway—*American Boots and Shoes in Denmark—Spinning Industry in Japan—*Commercial Education in Antwerp—Tonnage Dues at Lourenço Marquez—Bids for Coal in Brazil—Germany's Exports to the Balkan Peninsula.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

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**Dr. Issutschenko,** a Russian physician, has announced that he has discovered a microbe pathogenic to rats. An epidemic having broken out among rats kept for experimental purposes in the government agricultural laboratory, bacilli were isolated from the liver and spleen of the affected animals, and they proved very fatal to rats and mice. Further developments will be looked for with interest.

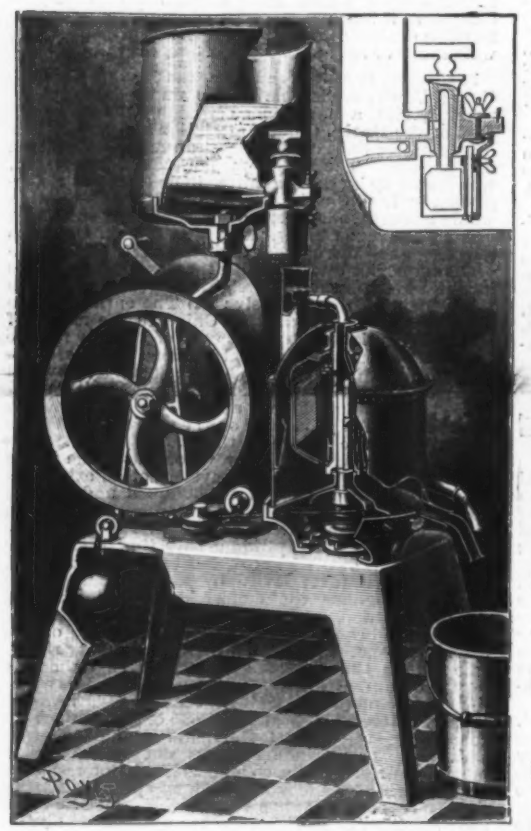
## THE FRAM CREAM SEPARATOR.

THE cream separator which we represent herewith from La Nature is the invention of Herr G. Daselking, of Hanover.

The motive power necessary to revolve the receptacle containing the milk to be creamed is obtained by means of a crank which, through a gearing, revolves a flywheel that acts by a cord upon the milk receptacle. As this cord is capable of undergoing elongations that would prove troublesome, it is made to pass around a pulley mounted upon a small carriage which a counterpoise has a constant tendency to pull backward, and which forms a very simple stretcher that operates perfectly.

The separator revolves upon a fixed pivot that does not need to be absolutely vertical, and so the apparatus may be installed upon a floor that is not perfectly level. This pivot is conical, and upon it is placed a sort of elongated sleeve that carries at its lower part the pulleys over which passes the driving cord. The summit of the sleeve is closed by a short pin which, through a ball, bears upon the top of the pivot. The body of the separator is provided with a recess in the center into which the sleeve enters and fits tightly, owing to the conical form of the two surfaces. Upon casting a glance at the figure, it will be seen that the apparatus is provided internally with a series of inclined disks forming truncated cones and presenting undulations that keep them at a certain distance apart. Into the space between two contiguous cones a certain quantity of milk can enter; and it is here especially that the separation takes place, the cream flowing toward the center, while the milk flows toward the sides of the receptacle.

In order to operate, one begins, then, by filling the upper reservoir with milk, and in regulating the flow that is to take place into the central recess of the separator. The milk escapes therefrom through four



THE FRAM CREAM SEPARATOR.

apertures (but two of which are shown in the figure), passes into a cylindrical chamber concentric with the central recess, and makes its exit through the small inclined tubes that are shown in the figure. At this moment, it is projected by centrifugal force against the sides of the creamer and flows between the inclined disks.

An inspection of the figure will show two small tubes situated along the walls of the creamer and descending so as to debouch at the bottom of the central recess. The milk, freed from cream, at the top of the reservoir, takes precisely this course in order to reach the bottom of the fixed receptacle that surrounds the creamer, whence it flows through the lowest cock seen to the right. As for the cream, that collects around the central cylinder and finally escapes through the aperture formed in the cover of the separator. It is thus possible for it to accumulate in the upper part of the jacket and flow through the corresponding cock.

We may add in conclusion that the truncated cones that assure the creaming are made of aluminum—a metal to which the cream does not adhere, but rather slides over with the greatest ease.

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**The Japanese** torpedo boats have received names entirely out of keeping with their modern style and destructive purposes. These names are very poetical and picturesque, and belong to the vocabulary of pure old Japanese words which are rapidly passing out of common use. The following are examples: "Dragon Fly," "Full Moon," "Moon in Clouds," "Sea Beach," "Pewit," "Lightning," "Thunder," "Dawn of Day," "Clustering Clouds," "Daybreak," "Ripples," "Evening Mist," "Dragon's Lamp," "Falcon," "Magpie," "White Naped Crane," "White Hawk."


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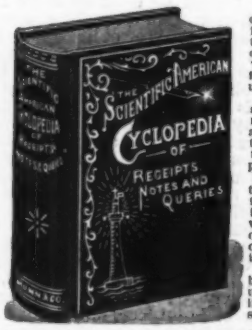


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